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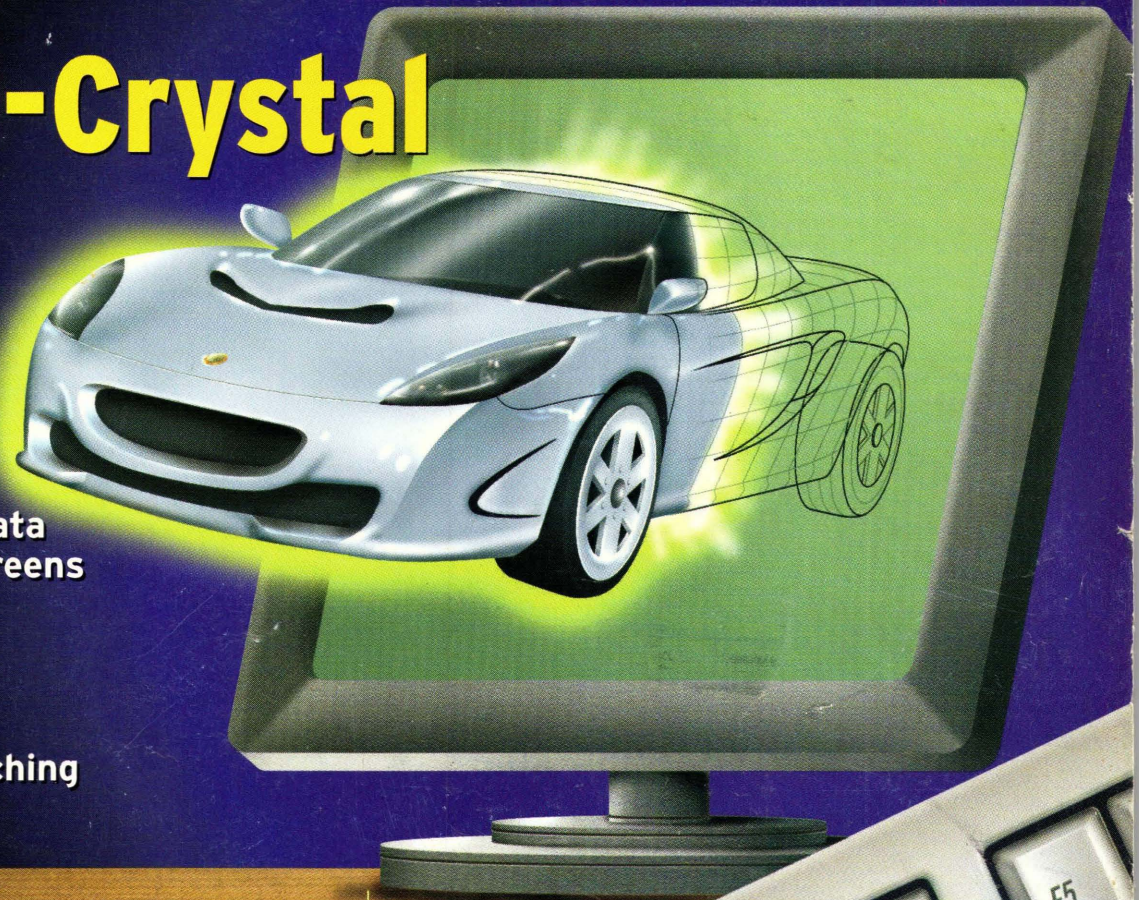

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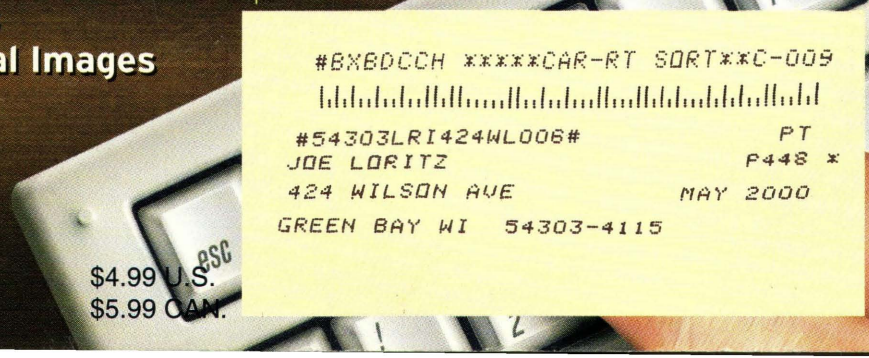

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The millennium is upon us. The year 2000 is right around the corner. What will it bring?
—***Poptronics*** – *the magazine for the hands-on electronics activist!*

Today's challenging electronics marketplace does not leave room for a variety of competitive publications aimed at the hands-on kind of electronics activist — the professionals who design, build, maintain, and repair all of the electronics gear that fills our lives, the experimenters who build projects, the computer enthusiasts who want to know what's in the latest gear, the activists who want to and are building robots, audiophiles who want to test new circuits and designs, ham-radio operators looking for what's out there to communicate with.

That's why Gernsback Publications has melded our two publications – *Popular Electronics* and *Electronics Now*, into this new, exciting and timely monthly magazine – ***Poptronics*** – that you now hold in your hands.

It's evolution! ***Poptronics*** is here! No matter what your specific interest in electronics; ***Poptronics*** is the magazine for all electronics activists in the 21st Century. We've been here since the beginning, when back in April 1908 we published the first issue of *Modern Electrics*. We're still going to be here for the start of the next millennium, the year 3001, with ***Poptronics*** or its future descendant.

We have brought all of the very best elements of our existing magazines into ***Poptronics.*** It is designed to deliver to you, our readers, the very best editorial variety we can assemble. We have packaged *Gizmo, Prototype, Hands-on Reports, Service Clinic, Peak Computing, Robotics Workshop, Amazing Science and other key columns;* and wrapped them around a main editorial package of construction projects, product lab reviews, how it works and how to do it articles, to create a wonderful new world of electronics for the new millennium!

Our web site at www.gernsback.com will still be there too. The forums, searchable index, and links will stay as they are, but you will find a lot of "under construction" signs in other areas. Keep logging in to keep up with what is happening. I believe that you will find our web site even more useful than before. We will continue the forums that bring thousands of readers to exchange ideas, get questions answered, and find the latest updates on contents in the magazine. It's a great place to search the index for old articles and to download current articles and artwork from the current issue.

If you are a current subscriber to *Popular Electronics*, you will automatically receive upcoming issues of ***Poptronics*** (starting with the January 2000 issue) until your current subscription is fulfilled. If you also subscribe to *Electronics Now* we will combine your subscriptions (if you have 10 more issues of *Popular Electronics* to go, and 5 issues of *Electronics Now* – for example – you will receive the next 15 issues of ***Poptronics***).

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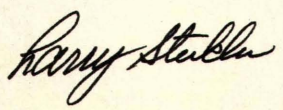
An exciting new world of electronics publishing began with the January 2000 issue of ***Poptronics.*** Be our partner in progress. Stay with us and see just how great our electronics industry can be. We will continue to bring you all of the latest electronics news as fast as it happens.

Larry Steckler, EHF,CET
Publisher



Electronics Now

March 2000, Vol. 1, No. 3

Popular Electronics®

Poptronics

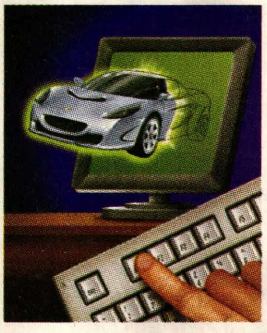
THE MAGAZINE FOR THE HANDS-ON ELECTRONICS ACTIVIST!

FEATURES

19 CUSTOM LIQUID-CRYSTAL DISPLAYS
Two articles that will help you add visual spice to future projects:

20 LCDs FOR PCs
Build an interface to display PC data on liquid-crystal panels.
— Michael Chan

27 PROGRAMMING LCD GRAPHICS
Use your new PC interface to bring images to life.
— Michael Chan



76 CURING RECEIVER OVERLOAD
Circuits and other solutions to a radio buff's common problem.
— Julian Kerr

PRODUCT REVIEWS

4 GIZMO®
Compact home theater, PC-free photo printer, speaking GPS, and more

6 HANDS-ON REPORT
Escient TuneBase 100 CD-Management System

DEPARTMENTS

8 PROTOTYPE
Bottled Water in a Box, Acoustic Holograms, Medical History on a "Chip," and more

33 SERVICE CLINIC
Keeping your VCR Happy

57 AMAZING SCIENCE
Geiger Counter

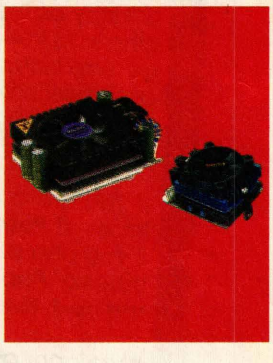
62 ROBOTICS WORKSHOP
Hands On: Using the OOPic Microcontroller

67 TECH MUSINGS
Fitting Bezier Curves, Machine-Tool Interface Details, PIC and Basic Stamp Books, and more

72 BASIC CIRCUITRY
Non-Mechanical Switch Circuits

HANDS-ON COMPUTING

39 UPGRADING A CPU
Squeeze extra life out of that old desktop computer. We look at two affordable, easy upgrades that will have your system buzzing through new applications.
— Ted Needleman



35 PC TECH®
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An MPEG-2/TV AGP Card
PC Gizmo®
Micron Millennia Max 533B
Ink Stamps from Graphics
Browser Timesavers

AND MORE

3 EDITORIAL
12 Q&A
16 NEW LITERATURE
81 NEW GEAR
PR-1 PRO SERVICE MAGAZINE
83 POPTRONICS SHOPPER
120 ADVERTISING INDEX
120A FREE INFORMATION CARD

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Editorial

How's a Hobbyist to Compete?

I can't imagine having to do certain things without the aid of technology. Maybe it's spoiled me, but the digital age has made life a lot better. Putting together a magazine in the pre-PC days, for instance, was tedious, involving a lot of retyping (on typewriters) and sticky cutting and pasting of page layouts. Now we can move around words and pictures onscreen with ease, focusing our efforts instead on planning, assigning, editing, proofing....

Okay, it still is work, just more manageable now.

Outside the office, I've grown to love polished gadgets of all types. The look of DVDs and bigger-than-30-inch TVs, the experience of surround sound, the convenience of portable MP3 players—I wouldn't part with them for anything. And don't expect me to travel without my laptop or, at least, handheld computer.

Though we're months away from it, I already love the 21st Century. It may fall short of some sci-fi predictions like Arthur C. Clarke's *2001*, but it will also be a lot less bleak than 20th Century writers imagined. I prefer my PCs and digital toys to a temperamental, intelligent computer out to kill me, thank you very much. Further, we can do without the one-style-fits-all jumpsuits of sci-fi films.

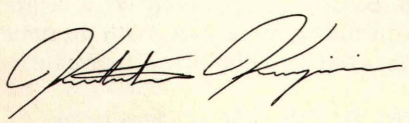
Seriously, consumer electronics are easy to use, nice to look at, and in some cases awe-inspiring. In the midst of my elation with how far we've come, I can't help but think about where modern advances leave the hobbyist. Once we built things that were too expensive to buy—now the cost of parts for a typical project far exceeds the price of a finished consumer version. Once we built things we couldn't find in the stores—now we shake our heads at how many great ideas are vying for store shelf space.

How can we compete?

We can't, that's obvious; but why should we want to? Being active in electronics today means going with the flow. It's no use grumbling in a corner about how "things were simpler before computers." Why not put the digital beasts to work and interface them with something you build? Why not create gadgets that contain computer technology? At the very worst, we'll come up with something impressive that cost us a bit too much yet taught us a lot. Or, maybe, we'll create that next consumer sensation and retire millionaires.

Regardless of what you do with your creations, make them reflect the age we live in. A good first step toward adding some modern glitz to your projects is found in this issue. Our LCD features will show you how to add slick, visual appeal to circuits that may once have contained only a flashing LED or irritating buzzer.

Working with the latest and greatest whenever possible—that may define our hobby in the new millennium. Don't let it intimidate you, though. We here at **Poptronics** will be exploring each new technology with you, hands-on.



Konstantinos Karagiannis
Editor

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Gernsback Publications, Inc.
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GIZMO®

Getting Personal

If there's one problem with home theater, it's that the "living" part of your living room tends to take a back seat to the electronics stored there. And if there's one problem with whole-house audio/video systems, it's that the controls tend to be in fixed locations, not always conveniently accessible by remote control.

Bose neatly solves both problems with its *Lifestyle 50 Home Theater System* ($3700). The Lifestyle 50 is designed so that everything is hidden from view with the exception of five tiny (4 1/2 × 2 1/4 × 3 1/4 inch) Jewel Cube speakers and the unique Personal Music Center remote control. That two-way wireless system controller, with its large touch screen, allows you to monitor and operate components in any room of the house.

The concealable Lifestyle 50 components include an Acoustimass powered bass module, a six-disc CD changer, and a multi-room interface box with built-in AM/FM tuner. Patented Acoustimass technology launches sound into the room through an air mass, delivering deep bass regardless of where the subwoofer is placed.

The Lifestyle 50 delivers five discrete channels of audio from 5.1-encoded digital soundtracks, along with the deep bass of the .1 channel. The system boasts an integrated Dolby Digital decoder, as well as Bose "Videostage" 5 decoding and post-processing, which is said to deliver a five-speaker experience with an onscreen center image and balanced surround from Pro Logic, stereo, or monaural sources.

One of the main features of this system is its flexibility. Listeners can program personalized CD playlists while listening to other sources. In addition, the radio component offers up to 25 AM and 25 FM station presets, which can either be organized by listening preferences or be "assigned" to various family members.

The multi-source/multi-room interface box provides inputs for additional sources, including two video sources, and the capability of "smart" outputs for controlling additional powered speaker systems in up to four rooms. The interface box uses radio-frequency signals to communicate with the Personal Music Controller.

The oval, two-handed controller is dominated by its large screen, which is operated with the touch of a finger. Its layered menu system delivers information on a need-to-know basis. Users are never overwhelmed with options (for example, when a CD is playing, the radio-controls display disappears). But the basic functions (on/off, volume up/down, and mute) are always displayed. The Room feature allows each area to be controlled independently, while the House feature allows all the speakers in the home to be turned on or off at once—or to have them all muted when the phone rings. A "find me" feature makes it easy to locate a misplaced system controller.

Bose, The Mountain, Framingham, MA 01701; 800-444-BOSE; *www.bose.com.*

CIRCLE 50 ON FREE INFORMATION CARD

Show Me the Way

Finding your way around an unfamiliar city can be difficult, especially when you're running late for an important meeting. RadioShack's *TravelStar GPS Driver Information System* ($349.99) uses signals from the Global Positioning System satellites and data stored in its memory to pinpoint the vehicle's location on an interstate road, a U.S. highway, or major state road. It provides distances between and directions to over 70,000 highway services and 7000 cities and towns across the country. For the top 250 major metropolitan areas, information is also provided on city services, cross streets, and local phone numbers.

Drivers don't have to strain to navigate using an onscreen map while on the move. The system gives directions in words instead. A keypad is used to select destinations or services; and information is displayed in large, easy-to-read words on the GPS screen. Because it's powered via a cigarette-lighter adapter, the Travel Star GPS can be transferred from vehicle to vehicle—including rental cars. With the optional Protection One security service, local dispatchers, who can be reached by calling a toll-free number, will give turn-by-turn directions or send help to your location.

RadioShack, 100 Throckmorton Street, Suite 1500, Ft. Worth, TX 76102; 800-THE-SHACK; *www.radioshack.com.*

CIRCLE 51 ON FREE INFORMATION CARD

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Colorful Sound

Remember when speakers were big, brown-and-black monoliths that sat squarely on the floor or rested atop heavy-duty stands? Boy, have things changed. Consider, for instance, the *LM 1 Leisure Monitors* ($350/pair) from B&W Loudspeaker of America. They're small, standing less than a foot tall on a 5½- × 7½-inch footprint. They come in five color schemes: matte black, pearl white, silver, and two-toned burgundy-red/silver and turquoise/silver. And while setting them atop floor stands is a possibility, their built-in stands provide several other options. Each speaker's smoothly integrated, contoured stand swivels to convert to a wall- or ceiling-mount bracket. Or it can be clamped down solidly (using the supplied Allen wrench) to a table or shelf.

The LM 1 speakers are equally versatile in function. They can be put to use in matched five-channel home-theater systems, and they are magnetically shielded for desktop use in multimedia computer setups. Their small size suggests use in tight quarters—for dorm, office, or bedroom audio systems. Finally, their weather-resistant drivers, enclosures, and electrical components allow the LM 1 speakers to be installed in bathrooms or covered pool areas.

The two-way LM 1 uses a long-throw/high-output, five-inch driver in a vented enclosure to achieve bass down to 65 Hz. The same driver delivers detailed mid-range reproduction and a seamless transition to the one-inch dome tweeter, which produces airy high-frequency audio to 20 kHz. The speaker is rated for a full 100 watts of power handling.

B&W Loudspeaker of America, 54 Concord Street, North Reading, MA 01864; 800-370-3740; *www.bwspeakers.com.*

CIRCLE 52 ON FREE INFORMATION CARD

PC-Free Digital Photos

Like the idea of digital photography but don't enjoy messing with computers? Hewlett-Packard's *HP PhotoSmart P1000* printer ($399) supports direct printing from digital cameras using Compact Flash (types I and II) cards or SmartMedia cards. Convenient front-panel buttons allow you to select photos and choose print size. HP's Color Layering Technology precisely places tiny ink drops to create vibrant colors and realistic skin tones, resulting in prints that look like photo-lab pictures. When photo paper is being used, the PhotoSmart printer produces prints with a resolution of 2400 × 1200 dots-per-inch (dpi).

If not in use as an in-home photo lab, the P1000 can serve as a PC peripheral for everyday printing. It outputs 11 black-and-white or 8.5 color pages per minute, printing up to 600 dpi in black and white. The printer offers USB and parallel-port connectivity.

Hewlett-Packard, 3000 Hanover Street, Palo Alto, CA 94304.

CIRCLE 53 ON FREE INFORMATION CARD

DVD/CD Mega-Changer

Is your DVD collection beginning to rival your CD library? Sony's *DVP-CX850* 200-disc carousel changer ($999) provides convenient storage for, and easy access to, DVDs and CDs. The Mega Control feature allows the DVP-CX850 to be linked to other Sony Mega-Storage CD changers. It also allows folks who have become accustomed to a CD mega-changer to take the DVD plunge without sacrificing the flexibility offered by a high-capacity changer. The changer features a built-in Dolby Digital decoder along with Digital Cinema Sound, which provides virtual surround effects.

The DVP-CX850 uses technologies that simplify cataloging, filing, and accessing discs. With DVD/CD text capability, the disc name (when encoded) is automatically displayed on the DVD player and the TV. Those discs that have not been encoded by the manufacturer can be named using the changer's Disc Memo feature.

Sony's Disc Navigator graphic user interface makes it easy to sort discs and create home-theater "libraries" by allowing them to be categorized by genre or into personalized folders. You could, for instance, "file" your *Titanic* DVD with the soundtrack CD or put all the animated films into your child's folder.

Sony, One Sony Drive, Park Ridge, NJ 07656; 800-222-SONY; *www.sony.com.*

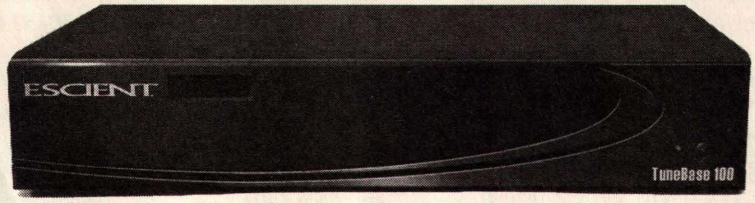
CIRCLE 54 ON FREE INFORMATION CARD

Escient TuneBase 100 CD-Management System

Easily organize and keep track of hundreds of CDs that you have stored in mega-changers.

So-called "convergence products"—ones that promise to seamlessly merge the worlds of computers and consumer electronics—have been heavily touted in recent years. Complete PC systems have yet to find a comfortable niche in the average family's home-entertainment center. But a few specialized computer-based products, such as set-top Web browsers, have made inroads into the living room.

The *TuneBase 100 CD-Management System* from Escient fits the basic definition of a convergence product, and it definitely deserves a place in the living room. It looks like a typical A/V component, but looks can be deceiving. A high-speed modem and the processing and data-storage capacity of a computer reside inside this basic 17 × 3½ × 14¼-inch black box.



Connect the TuneBase 100 between your TV and a compatible CD mega-changer, plug the TuneBase 100 into a phone line, and you've got direct access to the cover art, title, artist, and track information for hundreds of thousands of CDs. All of it can be displayed on the TV screen, and you don't have to input it. Suddenly, you have an effortless way to keep track of all 200 discs stored in your changer—or of all 600 discs stored in three daisy-chained changers. The device currently is compatible with Sony's CDP line and the Denon DCM-5000 and DCM-5001 changers; other brands and models will be supported in the future.

The disc information comes from two sources: some is stored in onboard memory, but most of it is available through an online music database company called CDDB (for Compact Disc Data Base), which happens to be owned by Escient. CDDB contains a huge amount of continually updated information. As we go to press, the database includes close to a half-million albums, and is growing at a rate of about 500 titles each day.

Getting Started, Keeping it Going. Setup is a straightforward matter of connecting the TuneBase 100's video output to the video input of your TV, plugging a phone wire into a phone jack for Internet access, and running the SX-100 adapter cable between the serial ports on the TuneBase and those on the changer. (On Sony changers, the serial port is labeled "S-Link control.") All the necessary cables are provided.

Once you've made those simple connections, the "hard" part begins: You have to load as many as 600 discs into your changers, and figure out where to put those now unnecessary jewel cases. Then you can sit back and rest as TuneBase begins using "IntelligentLink with AutoBuild" to identify every disc and download relevant data from the CDDB site. During the process, the onscreen display shows the time remaining, Internet connection status, and AutoBuild status.

When the process is complete—and it can take a half hour or so for a fully loaded 200-disc changer—you can view your CD collection on your TV screen. Opt to browse through cover art, and it's like flipping through the actual jewel boxes (though less messy, and always in alphabetical order). Nine covers are displayed on each screen. You can also scroll through your music library by viewing alphabetically arranged lists of artists' names, CD titles, or song titles. At all times, the currently selected ("Now Playing") disc is shown at the bottom left corner of the screen.

Yes, it's terrific to suddenly have so much information so conveniently displayed on the television. It's even better knowing that you didn't have to spend hours tediously inputting the data using some tiny remote-control buttons and that you'll never have to strain your eyes to read some small, scrolling front-panel display. But those are only the most basic TuneBase benefits.

AutoBuild is an ongoing, automatic process. Anytime you remove or insert a disc, TuneBase senses the change and either deletes the information or identifies and downloads the data for a new disc. You no longer have to remember in which slot a disc "belongs." Swap discs between your car and home changers, bring them to a friend's house, and don't worry about putting them back in the right spot. If you want to hear a certain song, just do an onscreen search for the track, the disc, or the artist, and TuneBase will find it.

Further, TuneBase provides several methods of personalizing your music choices. If there are other people living in the house and listening to the same stereo system, there will probably be some discs that some people don't want to

hear—ever. TuneBase's Select Style feature allows you to choose the music genres that you like and exclude the rest. Once you've made your choices, only discs that fit those music styles are displayed during searches or played in random-play mode. Discs are automatically categorized by genre, but you can override CDDB's typecasting, if needed, and even create your own categories. If "Rock" is too general, for instance, you can break it down into album rock, folk rock, classic rock, heavy metal, etc.

You can also create personalized playlists, including entire discs or individual songs. You might want to make dance mixes for parties or Christmas songs to play while decorating the tree or opening gifts. Family members might want to put their own discs into separate playlists, particularly if their musical tastes are wildly divergent.

Reliability? Just how accurate is TuneBase? Escient claims that for "mainstream" music collections, it will provide correct text information 95% of the time and find the cover art 60–70%. Those figures might be a bit modest; it did better than that with the discs we loaded, not all of which were "mainstream." It encountered the most difficulty with some boxed sets of jazz, failing to come up with the text or cover art. It also missed the cover art for a more "popular" three-disc Janis Joplin set and couldn't find either the cover or text data for Billy Bragg's *The Peel Sessions*. When it can't find the original cover art, TuneBase replaces it with one of several generic covers. (In the case of the Joplin set, discs one and three were given generic covers, while disc two showed the cover to her *Pearl* album. When the text information is missing or wrong, the included wireless keyboard can be used to make additions or corrections. I encountered very few mistakes, with the exception of one disc that had all the right text, but the wrong cover art.

One major glitch occurred during testing: For some unknown reason, the TuneBase 100 suddenly stopped recognizing all but six discs in the changer. The unit's "screen saver," which comes on when TuneBase is powered up but not being used, still showed the cover art of every disc in there, but there was no way to access any but those six CDs. It took two runs through the AutoBuild process—with the "detailed check of every slot" option selected—before the system finally "rediscovered" the missing music to the relief of everyone using the TuneBase 100.

The CD-management system brought new life to our CD libraries. Having such quick and easy access to hundreds of discs thousands of tracks changed the way we listened to music. We found ourselves spending much more time listening to CDs—time previously spent on "easier" entertainment options such as radio and TV.

If the TuneBase 100 was priced along the lines of other A/V components—or even a home computer—it would quickly find its way into everyone's living rooms. Unfortunately, its $3000 price tag pegs it as strictly an audiophile luxury.

For more information on TuneBase 100, contact Escient, LLC, 12955 Old Meridian Street, Suite 107, Carmel, IN 46032; 800-372-4368; *www.escient.com*; or circle 80 on the Free Information Card. P

A Convincing Performance at an Unbelievably Low Price!!

MOTOR CONTROLLER

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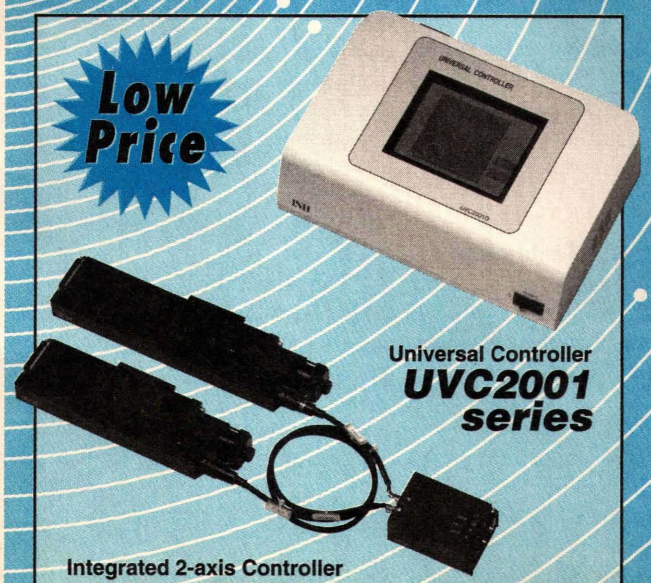

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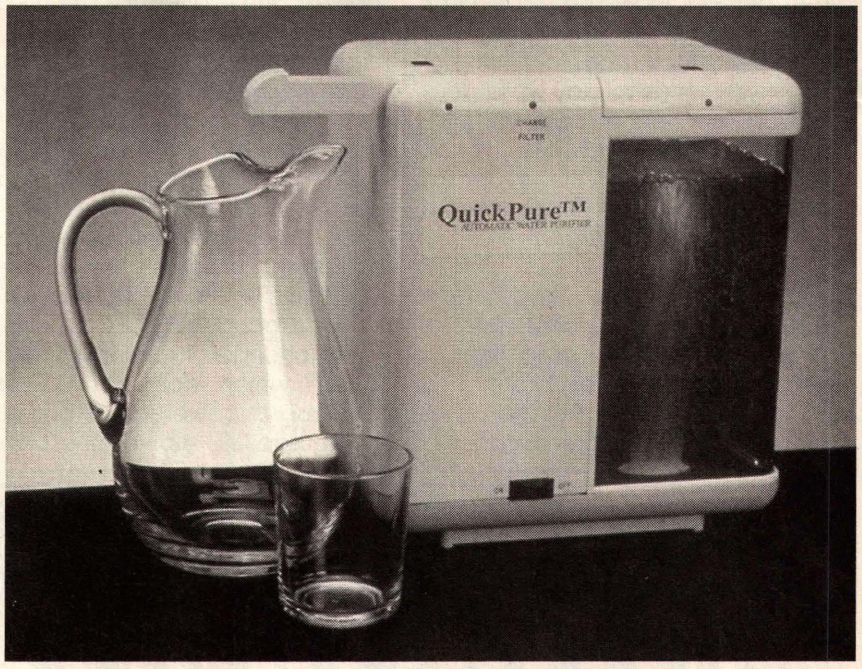
Prototype

Bottled Water in a Box

A prototype countertop appliance that purifies water almost instantly is the first prize winner in the Hammacher Schlemmer "Search for Invention" national competition—in the "Personal Electronics" category. Developed by ALAB, LLC, a research, engineering and design company, this brand new technology was chosen from a field of hundreds of submissions and was awarded a prize of $1000.

ALAB's invention radically "shrinks" the technology used to purify and improve the taste of water. With ALAB's patented, miniaturized technology, a countertop appliance the size of a food processor could produce the equivalent of a bottle of water at a cost of only about two cents a gallon—a tiny fraction of its price at the supermarket.



Shown here is ALAB's prototype water purifier. The countertop appliance purifies up to a gallon of tap water, which is ready to drink in three minutes.

Ozone is Generated Electrically

This technology uses ozone generated electrically from the air to kill protozoa, bacteria, and viruses and improve the water's taste. Until now, ozone water treatment has been a large-scale enterprise. More than 200 municipal water treatment facilities in the US use this method. In these plants, ozone-generating equipment is about the size of a railroad box car; while in water-bottling plants, ozone-generators are about the size of a refrigerator. The cost of such generators starts at approximately $5000 apiece.

Ozone, a form of oxygen, is about 100 times more powerful a disinfectant than chlorine. Ozone readily kills all common microorganisms, including chlorine-resistant ones such as cryptosporidium and giardia. In addition, ozone improves the taste of water, because it removes chlorine and oxidizes organic contaminants that cause taste problems. It also removes such impurities as iron and sulfur by precipitation after oxidation.

Almost all the bottled water sold in this country is treated with ozone because of its ability to improve purity and flavor.

Miniaturized Ozone Technology

ALAB has miniaturized ozone technology, so that its germ-killing potential can be tapped in small appliances. "The first application that we envision is the purification of drinking water within the home," said ALAB, LLC President W. Alan Burris, Ph.D. "But there are many other possibilities, including an instant contact lens cleaner that runs on batteries, and other health care appliances."

Over 20 years went into the research and development effort to reduce the scale of conventional ozone technology. As a result, ALAB was able to shrink the process by a factor of about 1000, compared to municipal systems. Further reductions in scale were achieved by changing the ozone generation process itself.

The miniaturized ozone generator is only about one-quarter of the size and cost of a similar device based on conventional technology. This small-scale technology generates ozone with an electrical corona. ALAB has several patents protecting various features of the process, which is now available for licensing by manufacturers.

Burris estimates that the water purifier could be sold for about $100 to $200

per unit. The life of a household unit is expected to be around 15 years.

How It Works

In one of the prototypes ALAB developed, the countertop appliance purifies up to a gallon of tap water. It pumps a thick column of sparkling, tiny ozone bubbles through the water in the reservoir. These pinpoint-sized bubbles dissolve ozone rapidly in the water, killing all the microorganisms present in the reservoir. After three minutes, the purification process is complete, the bubbles stop, and the device pumps the purified water into a pitcher. In another prototype, the appliance begins pumping purified water directly into the pitcher almost immediately after the button is pushed. In both models, the ozone is converted back to oxygen with a catalyst.

Both prototypes contain an activated carbon filter. Thus, the process that ALAB calls "QuickPure" provides both the purification and taste improvement of ozone and the benefits of regular water filters. With either model, the consumer simply plugs the appliance into a standard electrical outlet, pours tap water into the appliance's reservoir, turns on the switch, and waits for purified water to be pumped into a pitcher. The water can be drunk immediately or stored or refrigerated for later consumption.

The key advantage of such an appliance would be limitless supplies of good-tasting, pure water, at a small fraction of the cost of bottled water. There is no need to carry heavy bottles and no risk of running out in an emergency. Bottled water cost around $1 a gallon, while a gallon of water purified in this way costs about two cents.

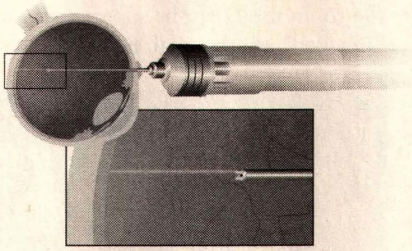
Other Applications

In many areas of the world, safe drinking water is in short supply. Because this new technology works on a small scale generating ozone to purify water and only needs small amounts of electricity, "QuickPure" could be very helpful in such places. Alternatively, these appliances could operate on batteries in areas where electric power is unavailable or unreliable. Additional information about the process, as well as technical details are given at the ALAB Web site: *www.quickpure.com.* PT

Keeping Eyes Safe

Precision is crucial during eye surgery—a slight miscalculation could result in partial blindness and damage to the retina. But a new sensor being developed could reduce those risks by alerting surgeons to the location of critical retinal tissue.

Researchers at the Department of Energy's (DOE) Pacific Northwest National Laboratory have designed and built a proximity sensor that would connect to an endoscope, the tool surgeons use when operating on the back of the eye. The sensor calculates the distance between the endoscope's needle and the retina and tissue.



This proximity sensor developed at Pacific Northwest National Laboratory will alert surgeons to the location of the retina during critical eye surgery.

Pacific Northwest is teaming with Johns Hopkins University's Microsurgery Advanced Design Laboratory (MADLAB) and Insight Instruments Inc. of Sanford, FL to share costs and results associated with the proximity sensor. MADLAB will conduct surgical tests of the sensor, while Insight Instruments Inc. plans to incorporate the device into endoscopes it manufactures.

"Many surgeons are apprehensive to use an endoscope because they don't know the proximity of the tool to crucial eye materials," said Peter Luloh, Insight's president. "This sensor could alleviate those concerns by alerting them when the tool approaches the retina, for example."

The proximity sensor relies on a fiber smaller than a strand of hair to transmit and receive light. The system begins by sending electricity into a laser diode, which connects to a fiber. The diode converts electricity into light, which then bounces back and forth along the fiber's walls until reaching the retina.

The retina absorbs about 80 percent of the energy and reflects the remaining 20 percent back to the proximity sensor. The reflected light travels back through the fiber to a photo diode, which converts the light into an electrical signal. An electronic circuit translates the voltage level into distance. If the distance reaches two millimeters or less, the system would trigger an audible alarm to alert the surgeon.

Researchers at Pacific Northwest tested this proof of concept in the laboratory in 1998. They are now building a second-generation proximity sensor to incorporate issues specific to eye surgery. For example, because the eye is extremely sensitive, the laser cannot exceed 37 microwatts, or .0027 percent of one watt. The MADLAB expects to conduct tests on patients this year.

Development of the proximity sensor was funded by the DOE. Further research could yield other applications for the device. The sensor could possibly be applied to other surgery, such as spinal operations that require surgeons to know the location of nerves. PT

Knees With Brains

In a unique arrangement, Sandia National Laboratories and a Russian laboratory, Chelyabinsk 70, are jointly developing technologies for foot and knee prosthetics. The Russians will design a titanium housing and Sandia robotics researchers will design the knee's internal workings and electronics. The project draws upon Russia's knowledge of materials and Sandia's electronic expertise to create, respectively, the shape and brains of the knee.

"This work will have many benefits," says Sandia chemist and project leader Mort Lieberman, who will also manage the Russian connection. "Someone in the world loses a limb to a landmine explosion every 20 minutes. Our work, though only remedial, will help landmine survivors and other amputees." He added that the collaboration is a good fit with the capabilities of both labs. It involves stress and materials analysis, mechanical and reliability testing, and microprocessor control.

The first joint project of the two labs was to develop an artificial foot. It has reached the stage where devices have

One version of a modern mechanical polycentric knee is pictured here. It weighs 1.37 pounds and is 4.12 inches high.

been experimentally affixed to amputees who volunteered. "I am amazed by your invention," writes Russian amputee Sergei Burlakov. He reportedly now can walk the entire day without experiencing the discomfort that formerly made him unable to wear a prosthesis for more than two or three hours.

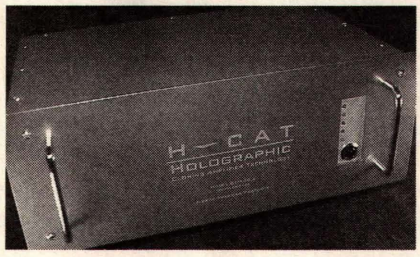
Designing a knee is even more complex. A knee must be able to vary the speed of its response. Then it needs to lock so that its wearer doesn't fall when standing. The knee is not simply a hinge, says Lieberman. If it were only that, it might swing back too far or not enough, letting the foot hit the ground too soon and causing its wearer to trip.

The labs are working with Ohio Willow Wood Company, which will define the requirements for parts and perform final lab and clinical testing. The project to develop an artificial knee is supported by a $1.4 million cooperative research and development agreement (CRADA) from the Department of Energy's Initiatives for Proliferation Prevention Program. PT

Acoustic Holograms

A virtually distortion-free amplifying process, "Holographic-cloning Amplifier Technology," H-CAT, is capable of reconstructing original sounds in an acoustic Hologram.

Recently introduced by North American Products (NAP), H-CAT can extract the sonic DNA—a virtual map of the physical locations of sound objects captured during recording and buried deep in the audio signal. This map can be read by the H-CAT nanoprocessor and used to "project" original sound objects back to their relative positions in the context of a Three-Dimensional Acoustic Hologram. H-CAT's ultra-high resolution is actually cloned from the original recording and deployed "in tact" as a naturally occurring acoustic hologram. The Acoustic Doppler Prevention System (ADPS) is built in and is capable of atmospheric emulation. (In atmospheric emulation, objects appear to occupy their own space, but within the environment of the viewer/listener.) A recording of instruments (including the room itself) can be superimposed or "attached" to the real listening room.



H-CAT, "Holographic-Cloning Amplifier Technology," can extract the sonic DNA and reproduce the original sounds. H-CAT's ultra-high resolution is actually cloned from the original recording and deployed "in tact" as a naturally occurring acoustic hologram.

According to a NAP spokesman, the comparison between real life and projection is seamless, and the technology produces voices that appear to come out of thin air rather than from speakers. He went on to say that the volume settings acted like a size or distance control for the transparent holographic image. By adjusting the playback level to match the physical size of the suspended objects, the sense of any electronic means vanishes, leading the brain to believe the listener is in a larger room.

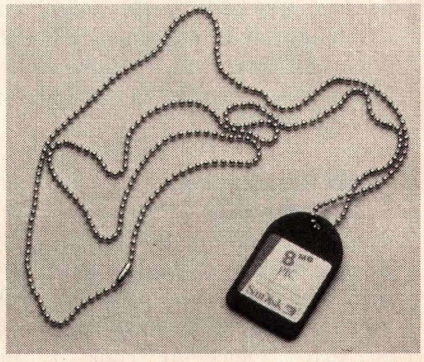
Similar to optical holograms that rely on a ruby laser to capture finite phase angles of a visual scene, H-CAT uses ADPS to program the main amplifier "engine" in a purely analog mode, but with exact values (as if it were in a digital domain.) The result is a method of amplifying by passing the entire signal through the amplifier without alteration. H-CAT does not involve the use of any filters, phase shifters, or "cross-channel" manipulation.

To the observer, the overwhelming lack of distortion and crystal clear suspended imaging is instantly recognized. Sound waves appear to travel through the observer's "air space" rather than being electronically delivered.

Since H-CAT amplifiers are capable of deploying a transparent 3-D sound field, it is a natural for linking acoustic holograms to 3-D movies/videos and other high-resolution media such as HDTV. Possible applications are in 3-D soundtracks for movies, in theme park amusements, in the music industry, for HDTV, for military/ police training, and in home entertainment systems. PT

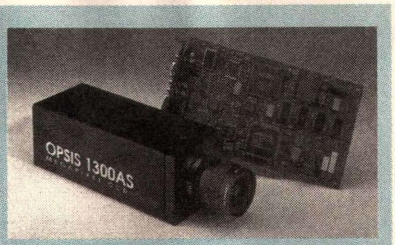
Medical History on A "Chip"

Presented as the world's first solid-state, wearable data-storage device, the Personal Information Carrier (PIC) is being supplied to the U.S. Army. Under contract to the Department of Defense (DoD), SanDisk and Kaneb Services, Inc. will provide the PICs. The rugged PICs are matchbook size, solid-state (no moving parts) flash-memory cards weighing only two grams, which use a low-cost, easily integrated serial interface. These next-generation electronic dog tags, worn around the neck by military personnel along with the tra-



Personal Information Carriers (PICs) are rugged, matchbook size, solid-state (no moving parts) flash-memory cards weighing only two grams. These next-generation electronic dog tags, which will be worn around the neck by military personnel, will store medical records and identification information.

➤ Toll Jumpers, Beware



The OPSIS 1300AS Megapixel Camera System will provide imaging for violation enforcement on the New Jersey turnpike system. Its combination of high-resolution imaging and built-in processing power allow it to capture clear images of rapidly moving objects.

With more than 50,000 tollgate violations a day, a foolproof, automated means of toll collection on New Jersey's turnpike system was obviously needed. First, a problem had to be solved: How to photograph the license plate of vehicles attempting to avoid the toll. Such photographs would have to be taken in all kinds of weather and traffic conditions.

MFS Technologies worked with Wintriss Engineering Company, a supplier of high-resolution, smart cameras for industrial quality control, to come up with the solution. Wintriss developed a fiber-optic version of its OPSIS 1300AS Megapixel Camera System. The camera will provide imaging for the New Jersey system's violation enforcement.

"The OPSIS 1300AS is ideal for use in traffic monitoring and control," explained Vic Wintriss. "Its combination of high-resolution imaging and built-in processing power allow it to capture clear images of rapidly moving objects under the most adverse of conditions, including high traffic volume, inclement weather, and poor lighting."

In addition, the fiber-optic version of the camera, which has been developed for the New Jersey system, has the added advantage of immunity to lightning strikes. Noting the frequency of electrical storm in New Jersey, Vic Wintriss pointed out that such a capability is essential. Also enhancing the camera's usefulness is the ease with which it can be programmed.

The New Jersey system is being developed under the auspices of the Regional Consortium for Electronic Toll Collection. Members of the consortium include the New Jersey Turnpike Authority, New Jersey Highway Authority, South Jersey Transportation Authority, Delaware Department of Transportation, Port Authority of New York, and Port Authority of New Jersey. Financing for the project will not incur taxpayer expense.

More than 300 locations in New York, New Jersey, and Delaware are scheduled to receive automated toll-collection systems, and the first one has already been installed on the Garden State Parkway. The project is expected to be completed by the end of 2000. PT

ditional dog tag, will store medical records and identification information.

The PIC is intended to fill the data gap that was identified during the Persian Gulf War. Several problems occurred. The past medical data of service personnel was not always available on the battlefield. In the paper-based system that was in use, treatments and exposures were not consistently documented and updated in the field. Incomplete and non-electronic medical records hindered collecting data for medical analysis of the Gulf War military population. According to the DoD, this complicated investigations into the Persian Gulf illness.

The PIC stores an abridged version of the individual's pertinent electronic medical record. The medical electronic dog tag will serve as the primary medical data source when connecting to a computer network is not practical. It will provide in-the-field medical workers with immediate access to the patient's vital clinical data.

Personal medical data is written to the PIC prior to the service member's deployment. If medical attention is needed in the field, medical personnel will use a desktop or laptop PC to access, update, and add to the medical data on the PIC. Once the person being treated reaches a site with a network connection, the PIC will update the central database. Security features, including a tamperproof ID, are built into the device.

Lt. Col. Bradley J. Dawkins, Air Force physician and project manager for the DoD's PIC Project, stated "The PIC can provide considerable value to the DoD and to individual service members. The PIC can be easily inserted into a laptop PC at a Battalion Aid Station, for example; and medical and identification data, such as allergies, blood type, and medication history, can be quickly obtained." PT

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Q&A

READERS' QUESTIONS, EDITORS' ANSWERS
CONDUCTED BY MICHAEL A. COVINGTON, N4TMI

Function Generator

Q *I need a design for an oscillator circuit to make a cheap function generator with a wide frequency range (from DC to at least 1 MHz), with sinewave, triangle wave, squarewave, and pulse outputs.—F. D., Quebec, Canada*

A We've published several function-generator construction projects recently. For example, **Electronics Now** ran such articles in August 1997 (a compact, portable unit), November 1995 (a benchtop unit with a digital-frequency display), and December 1994 (a benchtop unit that will do frequency sweeps). For the basic circuitry, see **Electronics Now**, January 1996. You can get reprints of two of those issues from our Reprint Bookstore (pre-1995 issues are no longer available); information on how to go about that is listed in our sidebar "How To Learn About Electronics."

Figure 1, reproduced from the January 1996 article, shows just how simple a waveform generator can be. The ICL8038 chip used in that circuit is available from many suppliers. One such supplier is Jameco, 1355 Shoreway Road, Belmont, CA 94002; Tel. 800-831-4242; Web: *www.jameco.com*. Their catalog part number is 58179 or "8038CCPD." You can also substitute the newer XR8038A.

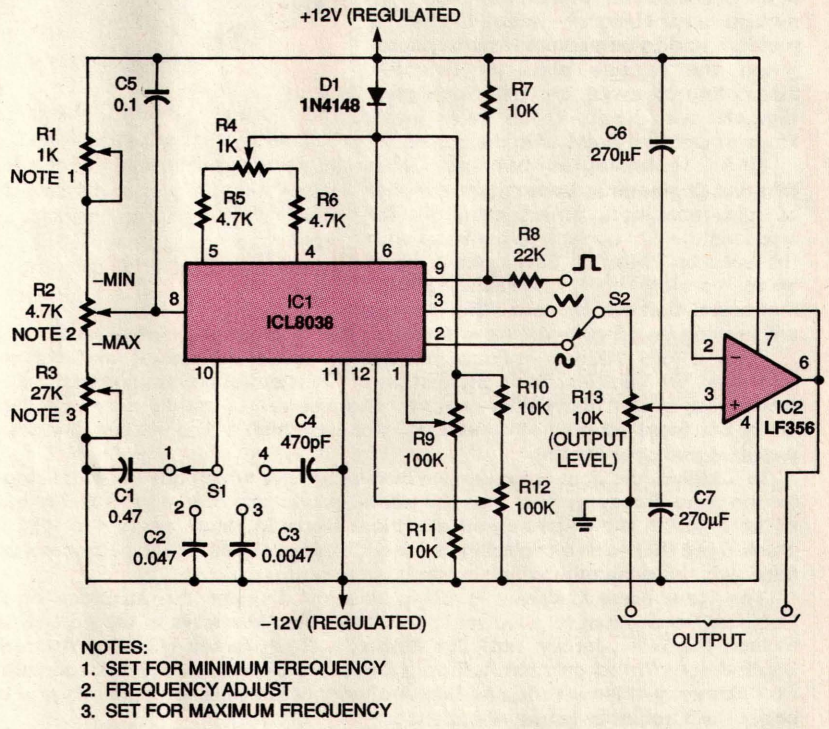

Fig. 1. This circuit, as originally published in the January 1996 issue of **Electronics Now**, *uses an ICL8038 function generator as the heart of a wide-range, variable-frequency waveform generator.*

ZN414 Wanted

Q *Where can I get the ZN414 AM-receiver chip used in the radio circuit that was published in the "Q&A" column that appeared in* **Electronics Now**, *November 1999?—J. W., Houston, TX*

A That chip was originally made by Ferranti, which was bought out by GEC Plessey Semiconductors, a British firm. In 1998, GEC sold Plessey to Mitel (*www.mitelsemi.com*). Unfortunately, the ZN414 seems to have gotten discontinued somewhere along the line.

After all, the ZN414 never had much of a commercial market. It was great fun for experimenters, but it's not practical to manufacture an IC unless millions of units are going to be sold to manufacturers of electronic equipment.

Fortunately, the ZN414 and many other hard-to-find parts for radio experimentation are still available from Ocean State Electronics, 6 Industrial Drive, Westerly, RI 02891; Tel. 800-866-6626; Web: *www.oselectronics.com*. Although not listed in their catalog, it is also reportedly still available, at a lower price, from Mouser Electronics, 958 N. Main, Mansfield, TX 76063; Tel. 800-346-6873; Web: *www.mouser.com*. Call them and ask; they get it from Philmore. We'd like to hear from readers who know of other suppliers of the ZN414.

Storing Video On A Chip

Q *I am trying to figure out how to store video and audio on a chip like those used in digital answering machines. Fifteen to thirty seconds of recording time are all that I need.—R. S. R., Mission Viejo, CA*

A Analog storage chips for recording sound, especially the human voice, are made by ISD, 2727 North First Street, San Jose, CA 95134; Tel. 800-677-0769; Web: *www.isd.com*. They are available from many suppliers, including RadioShack.

Unfortunately, storing video is not as easy. A video signal typically has 1000 times the information content, or bandwidth, of a speech signal. You can reduce that a bit by compressing the video and by taking frequent still pictures instead of a continuously-moving picture.

Even so, video requires perhaps 100 times as much memory space as sound; we are not aware of any simple one-chip circuits for storing it.

Burst-Locked Clock?

Q *I want to build an NTSC-composite-to-Y/C converter using a Sony CXD2073Q comb filter. That filter requires a "burst-locked clock" to be input to pin 25. What is that?—J. H., Palm Coast, FL*

A What you're building is a demodulator to separate luminance (brightness) from color in the TV signal.

When NTSC color television was developed in the 1940s, the designers had to find a way to "smuggle in" a color signal, hiding it somewhere inside a preexisting black-and-white signal that would still be compatible with black-and-white TV sets. They did that by phase-modulating the color onto a 3.58-MHz subcarrier.

To recover the color information, the TV receiver requires an oscillator that exactly matches the frequency and phase of the one in the TV camera. To achieve that match, the video signal includes a brief burst of 3.58-MHz oscillation during every retrace-blanking interval. A phase-locked loop in the TV receiver synchronizes itself to those 3.58-MHz bursts and produces a continuous 3.58-MHz signal.

In general, color-demodulation circuits are not simple. I suggest that you dig further among Sony's data sheets for more information about the circuitry that should be used with the chip that you've chosen. For general information on color-TV circuits, consult Kiver and Kaufman's *Television Electronics* (published by Van Nostrand Reinhold, 1983), and Hoff's *Consumer Electronics for Engineers* (Cambridge, 1998). Your local public library can probably obtain those titles on interlibrary loan.

Getting Audio From Digital Phone

Q *At our office, we have a multiline digital-telephone network. How can I tape-record phone calls for record-keeping purposes?—M. P., Quebec, Canada*

A As you note, the digital signal on the telephone line cannot be fed to a tape recorder or soundcard input. However, the signal in the telephone-handset cord is analog audio, and you can tap into it using a RadioShack 43-1237 adapter.

Take Your PIC...

Q *In the October 1999* **Electronics Now** *article on PIC assembly language, you mention the danger of letting pin 17 (A0) of the PIC16F84 float. Is there any danger in letting A1–A4 or other unused inputs float? Also, I have not been taking any special precautions against static charges, and my*

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HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at *www.gernsback.com* for information and files relating to **Poptronics** and our former magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www. motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online: www.questlink.com features IC data sheets and gives you the ability to buy many of the ICs in small quantities using a credit card. You can also get detailed IC information from www.icmaster.com, which is now free of charge although it formerly required a subscription. Extensive information about how to repair consumer electronic devices and computers can be found at *www.repairfaq.org*

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising over 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now, Popular Electronics** (post 1995 only) and **Poptronics** are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature,* available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214; (800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549, Tooele, UT 84074.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League, Newington, CT 06111; (http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

clumsy fingers are all over the pins; but I have not experienced any problems. Is this just dumb luck or is there some built-in static protection?—N.M., Wolcott, CT

A Taking the first question first, the reason pin A0 can't be left disconnected (floating) is that the PIC would read it as a zero or a one unpredictably. The other inputs are ignored by the PIC and do not need to be connected to anything.

It's actually an interesting question as to whether there is any reason not to leave unused inputs floating. With CMOS gates, you should not leave inputs floating because a floating input might pick up high-frequency noise, causing the gate to toggle very fast and consume extra power. Whether the same thing goes on inside a PIC's input circuitry, I'm not sure. You could certainly eliminate the problem by setting the unused pins to be outputs.

As for static, there is indeed some built-in protection, but it's not all-powerful. The hazard is greatest when humidity is low; you need more precautions in the winter than in the summer. I seldom wear grounded wrist straps, but I do use anti-static spray on the carpet and chairs, and I take care to touch grounded objects (such as the equipment chassis) before touching circuit components.

Cloning An 87C51

Q *Do you know of any company that could read the code from the Philips S87C51 microcontroller that was used in the power-line interface module of a Heath Most-Accurate Clock and program it into another 87C51 for use in repairing another clock? Those parts are no longer available from Heath.—S. E., New Orleans, LA*

A If the original 87C51 isn't read-protected, anybody who has a universal programmer can read it and program another chip to match it. The 87C51 is still in production and remains popular. There are companies that claim to be able to read the data from read-protected microcontrollers, but the process is somewhat iffy and we have no personal experience with them.

Copying a chip for purposes of repair is probably not a copyright infringement because you are merely replacing a chip that you are already licensed to have. Copying in order to build more clocks would violate Heath's copyright unless you could get written permission from them.

More About An Old Keyboard Amplifier

Q *Further to the October 1999 "Q&A" column in* **Electronics Now**, *the ELM127 transistor is a replacement made by Elmira Electronics, long out of business. All they did was substitute "ELM" for the "ECG" or "NTE" prefix.—Dan Goerss, N2YDK, by e-mail*

A Thanks! That implies that an ECG127 or NTE127 should do the trick as a replacement.

Vintage TI Calculator Books

Q *I am looking for some books published by Texas Instruments around 1982 on how to use a calculator. They covered areas like general electronics, investing, pharmacy, and the like; and they have been out of print for a long time. Does anyone have a copy they would sell or copy for me?—Jim Finnell, 601 Jenni Lane, Carson City, NV 89706; junglej@flash.net*

A We're publishing your address so readers can reply. I think that you're referring to the Texas Instruments Learning Center books, some of which were sold by RadioShack. They include *Fingertip Math* by Edward M. Roberts (1974), *Calculator Analysis for Business and Finance* by Roger F. Farish and others (1978), *The Great International Math On Keys Book* by Ralph A. Oliva and others (1974), *Sourcebook for Programmable Calculators* (staff-written, 1979), *Basic Electricity and DC Circuits* by Ralph A. Oliva and others (1979), *Basic AC Circuits* by Stanley R. Fulton (1981), and quite a few others.

To see the full list, go to *www.loc.gov* and search for books that have both "Texas" and "Instruments" in their GKEY records. Just to keep you amused, that will also dredge up a few books about the musical instruments of Texas.

Armed with exact titles and publication dates, you should be able to get those books on interlibrary loan through a nearby public or college library. Indeed, many larger libraries will already have them.

There was quite a flurry of "how to use your calculator" books in the late 1970s; I almost wrote one of them. Nowadays, the supply has dried up somewhat, but if you go to *www.amazon.com* and search for books whose title includes "calculator," you'll find quite a few. Surprisingly, *Calculators for Dummies* has not yet been written; will you be the one to do it?

Diodes Found

Q *I am unable to locate the silicon diodes listed as "ECG112" in the parts list for the RF Informant* (**Electronics Now**, *July 1999). What can I use as a substitute?—B. I., Brisbane, Australia*

A The diode in that circuit does not appear to be critical—any VHF or UHF diode should work, whether silicon, Schottky, or germanium. The common 1N34, OA47, or OA91 might work well enough to meet your needs and will certainly work well enough to tell you whether the rest of the circuit is functioning properly. The ECG112 is a silicon UHF-mixer diode; Schottky diodes should also work well.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to:

(1) include plenty of background information (we'll shorten your letter for publication);

(2) give your full name and address on your letter (not just the envelope);

(3) type your letter if possible, or write very neatly; and

(4) if you are asking about a circuit, include a complete diagram.

Questions can be sent to Q&A, **Poptronics** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735, or e-mailed to *q&a@gernsback.com*, but please do not expect an immediate reply (because of our backlog) and please don't send graphics files larger than 100K. Due to the volume of mail, we regret that we cannot give personal replies. P

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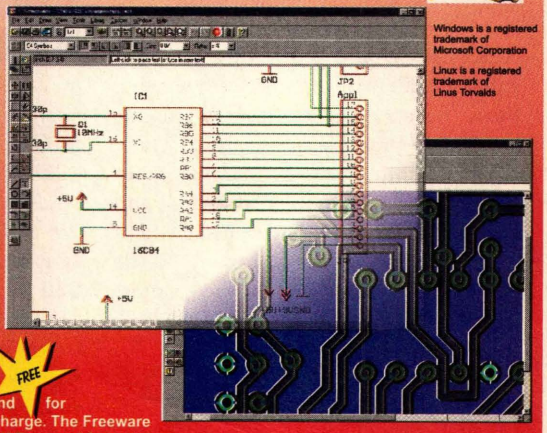

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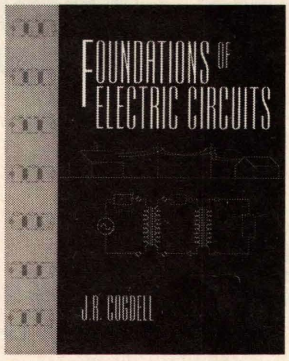
NEW LITERATURE

Foundations of Electric Circuits

by J. R. Cogdell
Prentice Hall
One Lake Street
Upper Saddle River, NJ 07458
Tel: 800-282-0693
Web: www.phptr.com
$36.80

Providing a thorough background in the basics of electric circuits, this textbook is geared toward students and serves as a clear introduction to this subject. It covers circuit theory, analysis of DC and AC circuits, circuit dynamics and analysis, and electric power systems.

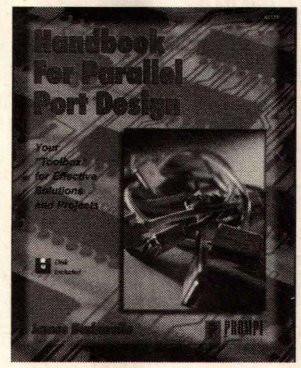


All the chapters begin with objectives and conclude with summaries reviewing those objectives. The author highlights key terms throughout the text. These terms are emphasized by marginal notes when they are first introduced and defined. There is a glossary at the end of each chapter that defines many of the key terms and refers to the context where the words first appear. Problems accompany each subject area.

Handbook for Parallel Port Design

by James Barbarello
Prompt Publications
Howard W. Sams & Company
2647 Waterfront Parkway, East Drive
Indianapolis, IN 46214-2041
Tel: 800-428-7267
Web: www.hwsams.com
$26.95 plus S&H

Methods of inputting to and outputting from the parallel port are organized logically from the simple to the more complex. Thorough explanations are given of how to use the display devices (LEDs) and input-sensing devices (light-sensitive resistors, IR LEDs, phototransistors, and rotary encoders).



An included companion diskette contains 52 support files, viewable in DOS, Windows, or QBasic. These data and executable files will help readers better understand and master the concepts presented, such as: Keycard Circuit Alignment, Rotary Encoder Demonstration, ADC Application, and Computer-Based Logic Probe Application.

GSM Superphones

by Lawrence Harte, Richard Levine, and Geoff Livingston
McGraw-Hill
1221 Avenue of the Americas
New York, NY 10020
Tel: 800-2MCGRAW
Web: www.ee.mcgraw-hill.com
$60

Designed for managers, technicians, and others involved with GSM wireless telephones and systems, this book presents readers with a detailed description of the technology. It also provides references for suppliers and industry specifications. Its clear, readable text and numerous examples and case studies make GSM easy to understand.

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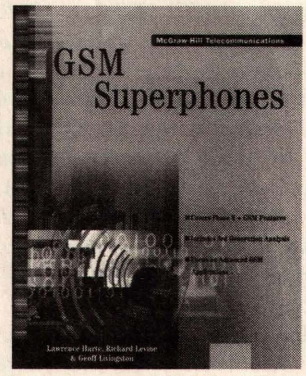
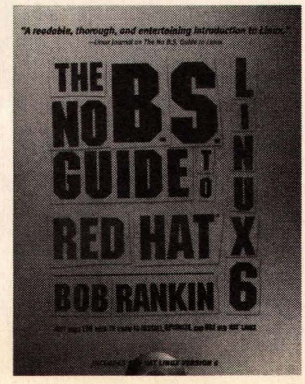


There are lists of all the major GSM component and network suppliers, a critical overview of technologies and services, and an examination of marketplace movement. Future developments for GSM are also discussed.

The No B.S. Guide to Red Hat Linux 6

by Bob Rankin
No Starch Press
555 De Haro Street, Suite 250
San Francisco, CA 94107
Tel: 800-420-7240
Web: www.nostarch.com
$34.95

This easy-to-understand guide describes the fundamentals of the Red Hat Linux 6 operating system, and what end users need to know to install and run Red Hat Linux 6 with a minimum of fuss. There are straightforward instructions for doing the installation in ten easy steps. In addition, the author explains how to use and configure GNOME—the new Linux GUI.



Readers will learn to write Bash or Perl scripts and to use the Bash shell. Also covered are the methods of: connecting to the Internet with SLIP/PPP, running the Apache Web server, accessing DOS files, and running Windows programs under Linux. The included CD-ROM contains the latest distribution of Red Hat Linux 6.

Measurement Products Catalog (2000 Edition)

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Web: www.tektronix.com/mbd/catalog_request
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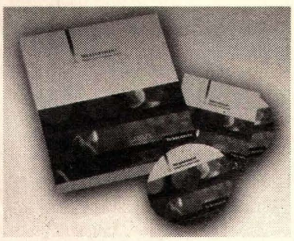
Available in paper and on CD-ROM, the catalog features a broad offering of test products. The 600-page soft-cover catalog includes a full-color new product section that highlights new products and measurement solutions for Rambus systems, RF design, and mobile and core telecommunications networks. Extensive indexes list products by name and function, as well as by categories such as oscilloscopes, logic analyzers, telecommunications, and television test products.



In addition to the paper catalog, measurement product information is also available on CD-ROM and on the Web: *www.tektronix.com/home/products.html*. The CD-ROM offers quick and easy access to data sheets and contact information, and it provides more than 20 selection guides and tutorials.

Police Call: 2000 Edition

edited by Richard Barnett
Hollins Radio Data
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Los Angeles, CA 90035
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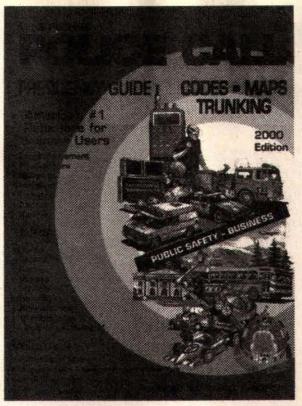

$12.99 per volume plus $3.95 S&H

Considered "the scanner user's bible," the 2000 edition is the largest ever. The nine regional volumes contain over 35,000 frequencies. This guide is now also available on CD-ROM.

Volume I covers New York and New England. In addition to emergency agencies, such as Police and Fire, the books list two-way frequencies for 18 additional categories, including aircraft, federal government, transportation, sports, entertainment, and more.

Crash Course in PC and Microcontroller Technology

by Louis E. Frenzel, Jr.
Newnes, Butterworth-Heinemann
225 Wildwood Avenue
Woburn, MA 01801
Tel: 800-366-2665 or 781-904-2500
Web: www.bh.com
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Covering both hardware and software for single-chip embedded controllers, as well as PC architecture, this book provides a self-paced introduction to microprocessors. In an easy-to-understand format, the basics of microcomputer organization and operation, as well as applications, are explored in detail, with clear explanations and examples.

The book is organized with learning objectives and a self-quiz for each chapter. Self-testing is provided by the included drill-and-review software, which further reinforces the material. P

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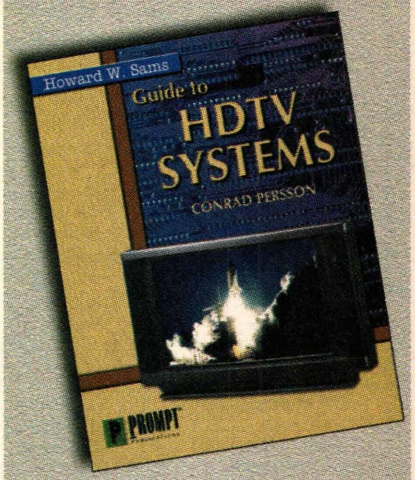

GUIDE TO HDTV SYSTEMS
by Conrad Persson

As HDTV is developed, refined, and becomes more available to the masses, technicians will be required to service them. Up until now, precious little information has been available on the subject. This book provides a detailed background on what HDTV signals are generated and transmitted, and a generalized description of the circuitry an HDTV set consists of. Some of the topics include the ATSC digital TV standard receiver characteristics, NTSC/HDTV compatibility, scanning methods, test equipment, servicing considerations, and more.

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☐ **BP327–DOS: One Step at a Time $5.99.** Although you spend most of your time working with a word processor, spreadsheet or database, and are probably quite happy using its file management facilities, there will be times when you absolutely need to use DOS to carry out 'housekeeping' functions. The book starts with an overview of DOS, and later chapters cover the commands for handling disks, directories and files.

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☐ **BP136—25 Simple Indoor and Window Aerials $2.99.** Many people live in flats and apartments where outdoor antennas are prohibited. This does not mean you have to forgo shortwave listening, for even a 20-foot length of wire stretched out under a rug in a room can produce acceptable results. However, with experimentation and some tips, you may well be able to improve further your radio's reception. Included are 25 indoor and window antennas that are proven performers. Much information is also given on shortwave bands, antenna directivity, time zones, dimensions, etc. A must book for all amateur radio enthusiasts.

☐ **BP379—30 Simple IC Terminal Block Projects $6.99.** Here are 30 easy-to-build IC projects almost anyone can build. Requiring an IC and a few additional components, the book's 'black-box' building technique enables and encourages the constructor to progress to more advanced projects. Some of which are: timer projects, op-amp projects, counter projects, NAND-gate projects, and more.

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☐ **ETT1—Wireless & Electrical Cyclopedia $4.99.** Step back to the 1920's with this reprinted catalog from the Electro Importing Company. Antiquity displayed on every page with items priced as low as 3 cents. Product descriptions include: Radio components, kits, motors and dynamos, Leyden jars, hot-wire meters, carbon mikes and more. The perfect gift for a radio antique collector.

☐ **BP93–Electronic Timer Projects $2.99.** This book covers many of the possible applications of timer circuits. These circuits may turn on or off at either some preset time or after an elapsed time. Some of the more complicated timer and clock circuits are made up from a number of simpler circuits that the author deals with individually. Also included are several special interest circuits such as cars windshield wiper delay unit, a darkroom timer, metronome, etc.

☐ **BP88–How To Use Op-Amps $5.99.** Written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. There are chapters on Meet the Operational Amplifier, Basic Circuits, Oscillators, Audio Circuits, Filters, Miscellaneous Circuits, Common Op Amps, Power Supplies and Construction Notes and Fault Finding.

☐ **BP76–Power Supply Projects $3.99.** Presents a number of power-supply designs including simpled unbiased types, fixed voltage-regulated types and variable voltage stabilized designs. All are low-voltage types intended for use with semiconductor circuits. Apart from presenting a variety of designs that will satisfy most applications, the data in this book should help the reader to design his own power supplies. An essential addition to the experimenters electronics library.

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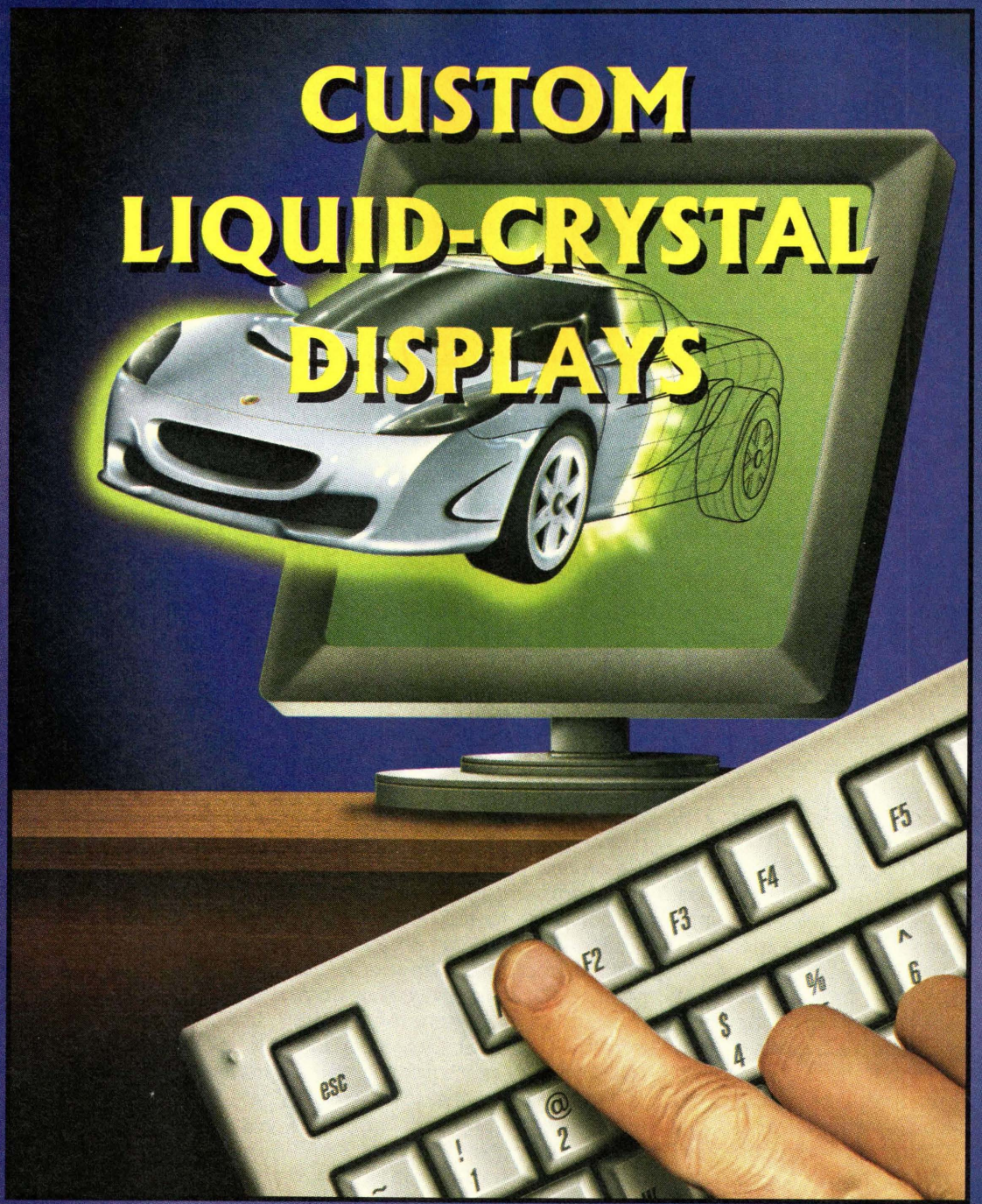


LCDs for PCs.....20
Programming LCD Graphics.....27

Connecting a liquid-crystal display to a computer is easy and useful. Here's how!

MICHAEL CHAN

Liquid-crystal displays (LCDs) seem to be everywhere nowadays. Rare is the piece of electronic equipment that doesn't sport a display of some type. In the past, simple light-emitting diodes (LEDs) or even seven-segment displays seemed to be the "cutting edge" of user-feedback technology. However, if today's gear doesn't spew out an endless array of information, it seems antiquated and hopelessly out of step with the 21st century.

Fortunately, modern LCDs, whether text- or graphics-based, have quite a bit of "intelligence" built into them when it comes to the "nitty gritty" of running an actual LCD. While this built-in intelligence might hide the technical side of how the devices actually work, having this capacity makes them easy to add to any computer-based project.

Have you ever wondered how to use an LCD in your next home-brew project or how to use a computer to control various devices? If you sit down, relax, and spend a few minutes with us, we'll present a very simple project that does both. Specifically, our project will demonstrate how easy it is to make a computer "see" light and display messages on an LCD. Instead of investing your money on computer-interface cards, software, or expensive electronic parts, the only item you'll need is an intelligent LCD display; that PC sitting in the corner should have the rest: a printer port and a BASIC compiler. The increasing popularity of LCDs results in their prices dropping fast. With a PC (anything from an XT to a Pentium III) and about $50 in electronic parts, you are set to begin exploring this growing technology.

Printer Ports. Before we begin, there are two major areas in this project that need to be explained: the printer port and LCD operations. We will deal with the printer port first.

A computer uses various input/output ports to talk to peripheral equipment, such as printers, monitors, keyboards, and modems. The printer port provides two-way communication between the printer and the computer. During printing, the computer sends printing codes to the printer. At the same time, it receives status reports from the printer, like "out of paper" or "busy" signals. We will use those channels to link the computer and the LCD.

TABLE 1
PRINTER-PORT ADDRESSES

Bit No.	Port 0378	Port 0379	Port 037A
0	2		1
1	3		14
2	4		16
3	5	15	17
4	6	13	
5	7	12	
6	8	10	
7	9	11	

In general, three addresses are used for exchanging information through the printer port. Two of them are used for outgoing signals only; the third is for reading back status information from the printer. Table 1 details which address is connected to which pins on the actual printer-port connector.

These addresses, by the way, are in the *hexadecimal*, or "base-16," format. Hexadecimal, a numerical format that should be familiar to the computer-savvy reader, is an easy-to-understand way to describe binary numbers. Each symbol represents a group of four binary bits. With four bits, 16 different combinations (from 0000 to 1111) are possible. The numbers 0 through 9 are used in the usual way, but the trick is how to represent the numbers 10 through 15 with a single symbol; that is where the letters A through F come into play.

It will make a bit more sense if you take a fresh look at how we represent numbers in our base-10 system. For example, the number 157 is actually 7×10^0 (a fancy way to say "7×1") + 5×10^1 (or "5×10") + 1×10^2 (or "1×100"). Now we'll do the same math in hexadecimal: 378 is 8×16^0 (or 8) + 7×16^1 (or 112) + 3×16^2 (16 squared is 256, so the product is 768). In base 10, 8+112+768 is 888—378.

Now that you have an understanding of the math used in cal-

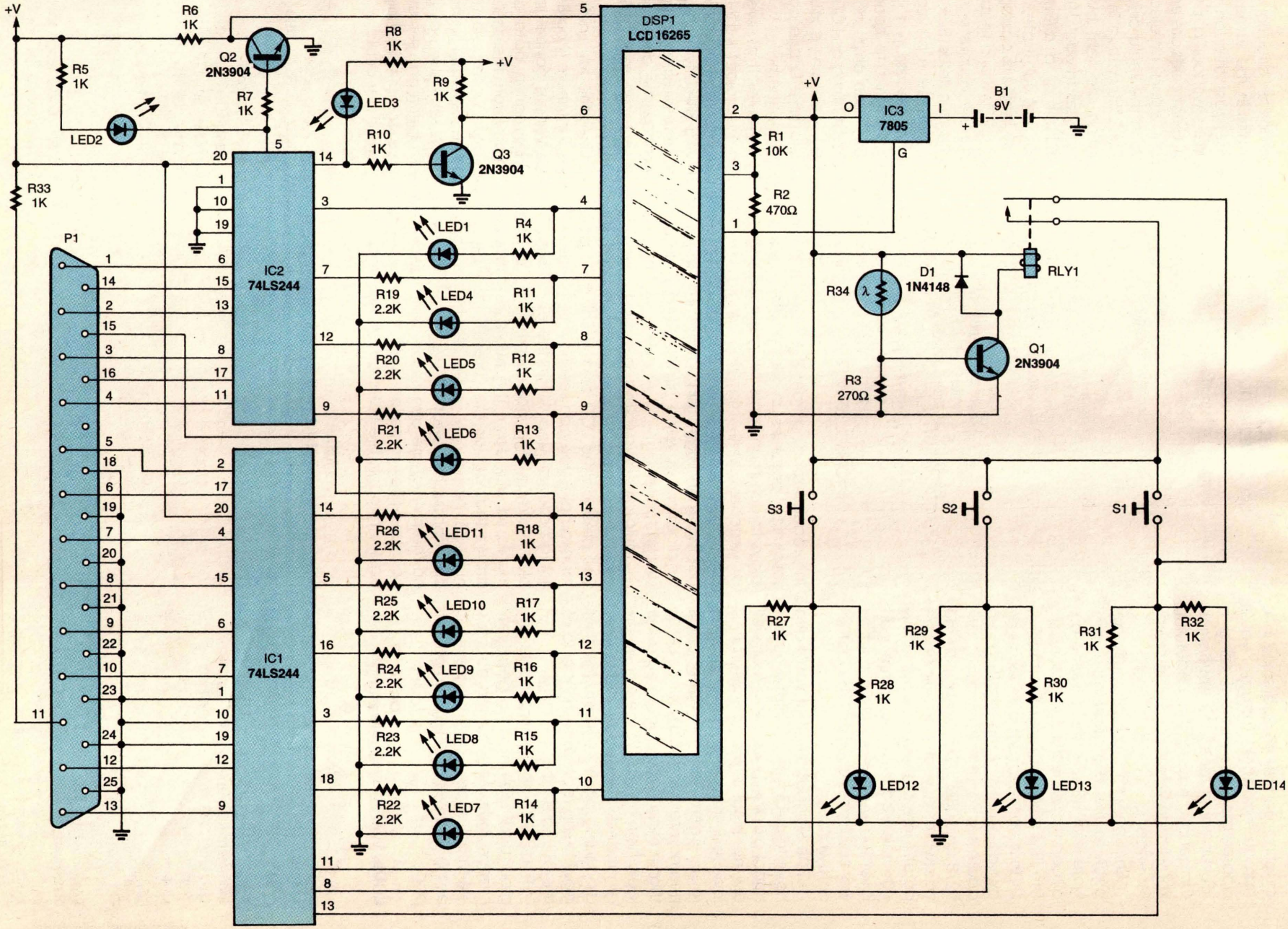


Fig. 1. Interfacing an intelligent LCD display to a printer port is simple and straightforward. Included are a series of LEDs to monitor the state of the interface lines.

culating computer addresses in a human-readable format, you'll appreciate the ease of using a lookup table for such conversions. Of course, having the underlying knowledge lets you double-check for errors.

Enough with the math; let's get back to the computer hardware! Note that the three addresses are all connected with *one* printer port. The IBM standard specifies that up to *three* printer ports can exist side by side on one computer. The base addresses for the other ports are 0278 and 03BC. Depending on the hardware in your particular computer, there are several ways to find out which address your printer port is set for; we'll deal with that when we build and connect the actual hardware.

One slight oddity that you'll also have to deal with is that the output signal on pins 1, 14, and 17, as well as the input signal on pin 11, is inverted from the other pins—a requirement of the Centronics printer-interface standard. Keep that in mind if you want to output a logic high on pin 17; the pin will be grounded instead! Likewise, grounding pin 11 will result in that input being read as high instead of the expected low.

Pins 18–25 of the printer port are grounded. They make a good reference between the computer's electrical supply and whatever is being connected to the printer port.

LCDs. LCDs have gained wide use in products ranging from the high-resolution graphics in video displays to common items like pagers or watches. While manufacturing the LCDs themselves requires top-notch technology, using them in applications is quite simple and straightforward.

Liquid-crystal displays are built around just that: a liquid crystal. If you press on the LCD of a watch, for example, you can see how the liquid oozes around within the display. Normally, light passes through the liquid with ease. The two substrates that act as the "bread" in our LCD "sandwich" have electrically-conductive electrodes etched on them; they are also made from polarized-filter material. Light that passes through the first substrate is polarized in a certain direction. As long as it remains in the same orientation, it will pass through the second substrate without a problem. When the electrodes are energized with an AC signal, an electric field is created in the liquid crystal. The strands of crystal material in the field twist, turning the light by 90 degrees as it passes through. With the polarized light at a different angle from the first substrate, the second substrate blocks its passage.

Making an LCD work requires precisely timing the various signals to create the electric fields. Building such a circuit can be a bit tricky. However, it is not necessary to do that nowadays thanks to special interface chips. Those chips do all the hard work of running an LCD. In addition, they contain enough "intelligence" to take simple commands and act on them.

The LCD module that we're going to use in this project is a 2-line by 16-character display that employs the Hitachi HD44780A driver chip to run the dot-matrix liquid-crystal display. Knowing how the driver chip works allows us to do many tricks with the LCD.

Table 2 outlines the terminals of the LCD. Note that there is an 8-bit data bus plus various control lines for passing information data and instructions to and from the display. The display driver interprets the incoming signals as either instructions to perform tasks such as display clear, text shift, mode set, etc., or as data to be stored in the chip's read/write memory for display.

TABLE 2
LCD PIN FUNCTIONS

Pin No.	Symbol	Function
1	V^{ss}	Ground
2	V^{dd}	+5V Power Supply
3	V^{o}	Negative voltage supply for LCD driver
4	RS	Register Select: 1 for data; 0 for instruction code
5	RW	Read/Write: 1 to read; 0 to write into module
6	E	State data read/write
7–14	DB0–DB7	Bi-directional data bus terminals
15	A	Positive supply for backlight (4.2V)
16	K	Negative supply for backlight

TABLE 3
LCD COMMANDS

Instruction	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Clear Display, set home display location (address counter AC=0)	0	0	0	0	0	0	0	0	0	1
Return home (AC=0)	0	0	0	0	0	0	0	0	1	x
Increment AC display left to right	0	0	0	0	0	0	0	1	1	0
Decrement AC display right to left	0	0	0	0	0	0	0	1	0	0
Display ON	0	0	0	0	0	0	1	1	0	0
Display OFF	0	0	0	0	0	0	1	0	0	0
Display shift left	0	0	0	0	0	1	1	0	x	x
Display shift right	0	0	0	0	0	1	0	1	x	x
Set display RAM address (RAM data is sent/received after this setting)	0	0	1	a	a	a	a	a	a	a
Write data to Display RAM	1	0	d	d	d	d	d	d	d	d
Read data to Display RAM	1	1	d	d	d	d	d	d	d	d

Notes: x=don't care (1 or 0)
a=address data
d=display data

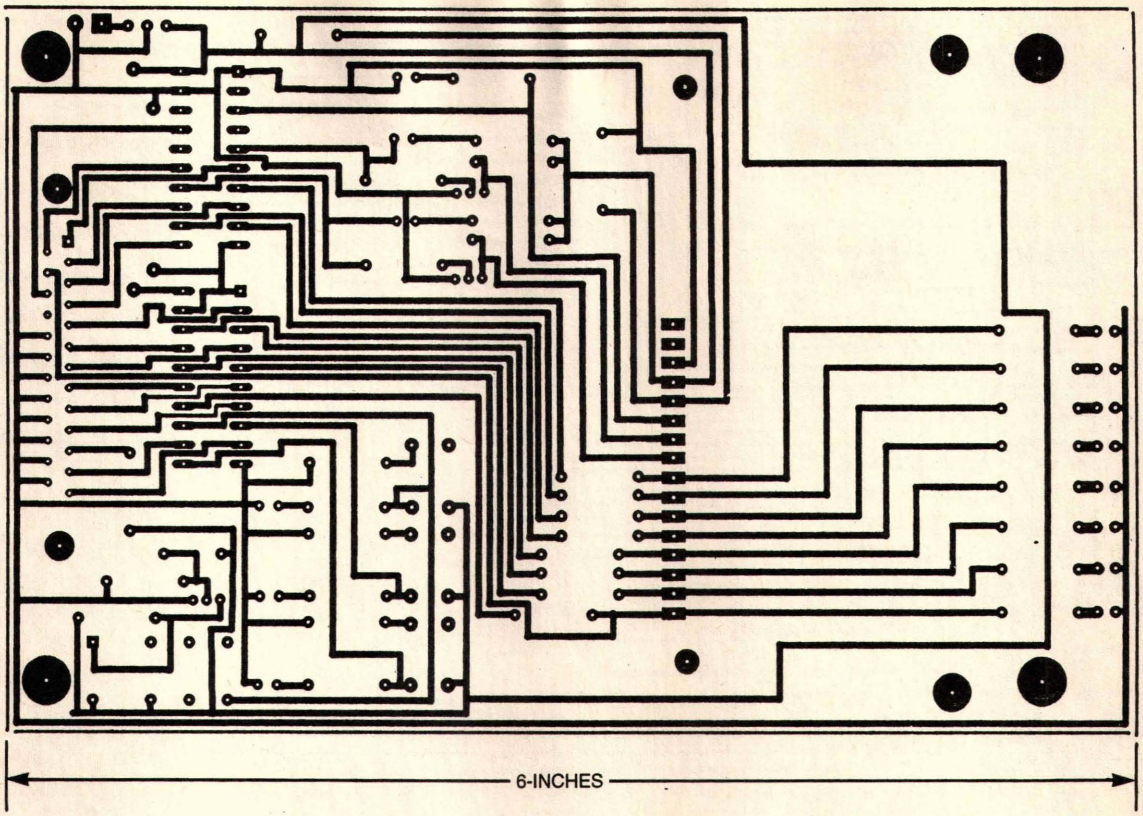


Fig. 2. The LCD interface fits on a single-sided PC board, as this foil pattern shows.

LCD Instructions. When power is turned on, the LCD module goes through a self-initialization process. The unit defaults to a one-line display with an eight-bit data-length interface. The module understands several commands and functions; these instructions are detailed in Table 3.

Note that there are two control lines: RW and RS. The first one controls the direction of the data bus—"0" for writing to the LCD and "1" for reading data from it. The other control line stands for "register select." When it is a zero, the data bus contains control instructions; otherwise, it would contain display data.

One additional control pin on the LCD module is the "E" pin. It is a type of "gate" or "enable" control that opens up the LCD module's data-bus latches. To read or write data to (or from) the LCD, the enable pin must be held high; when it is returned low, the signals on the data lines are captured by the LCD.

Using this information about the enable pin, let's see how we actually communicate with the LCD. As an example, let's tell the LCD to clear its display screen. According to Table 3, the data lines must contain 00000001, and the RS and RW lines must be zero. Assuming that the printer-port address is 0378, we start by sending 00000100 to address 037A; that activates the strobe line and opens the LCD for receiving a command. The reset command 00000001 is then sent to address 0378. Finally, 00000000 is sent to 037A to return the E line to its idle state.

The above steps could easily be done with the following BASIC commands:

PARTS LIST FOR THE LCD-PRINTER PORT INTERFACE

SEMICONDUCTORS

IC1, IC2—74LS244 line driver, integrated circuit
IC3—LM7805 fixed 5-volt regulator, integrated circuit
Q1–Q3—2N3904 NPN transistor
LED1–LED14—Light-emitting diode, any color

RESISTORS

(All resistors are 1/4-watt, 5% units, unless otherwise noted.)
R1—10,000-ohm
R2—470-ohm
R3—270-ohm
R4–R18, R27–R33—1000-ohm
R19–R26—2200-ohm
R34—Light-dependent resistor (RadioShack 276-1657 or similar)

ADDITIONAL PARTS AND MATERIALS

B1—9-volt battery
DISP1—16265 2-line by 16-character liquid-crystal display (Optrex)
P1—25-pin D-subminiature plug, PC-mount
RLY1—Single-pole, single-throw, 5-volt relay
S1–S3—Single-pole, single-throw, momentary-contact switch, PC-mount
9-volt battery clip, wire, hardware, etc.

Note: The following is available from Supremetronics Inc., 333 Queens Street W., Toronto, Ontario, M5V 2A4 Canada; Tel: 416-598-9585; Web: *www.geocities.com/SiliconValley/Foothills/1897/* : Complete kit of parts, manual, PC board, and programs, $83 ($122 Canadian). Please add $6 Canadian for shipping and handling. Canadian residents must add appropriate PST and GST. Money order or credit card payment accepted.

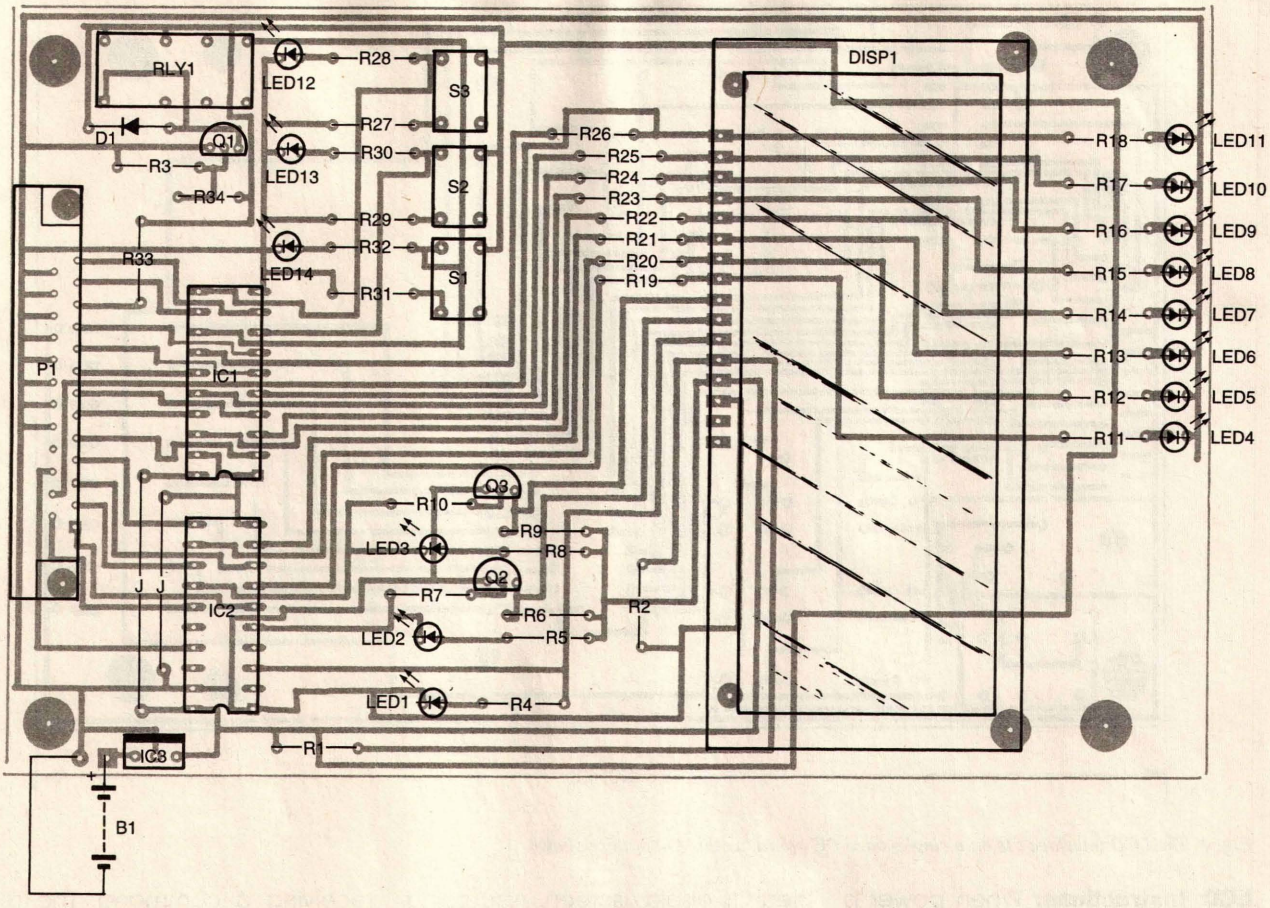


Fig. 3. When building the LCD interface, don't forget the two jumper wires in the corner.

```
out &H37A, &H04
print
out &H378, &H01
print
out &H37A, &H00
```

Let's follow that up by writing the capital "A" character to the LCD screen. This time, we start by sending 00000110 to address 037A; not only does the third bit activate the LCD controller, but the addition of the second bit tells the LCD to display the information on the data bus. The data bus (address 0378) is set to 01000001 (the ASCII code for "A"). Finally, 00000010 is sent to 037A. Note that we keep the RS line high while deactivating the E line.

As per our previous example, we can translate that into a simple set of BASIC commands:

```
out &H37A, &H06
print
out &H378, &H41
print
out &H37A, &H02
```

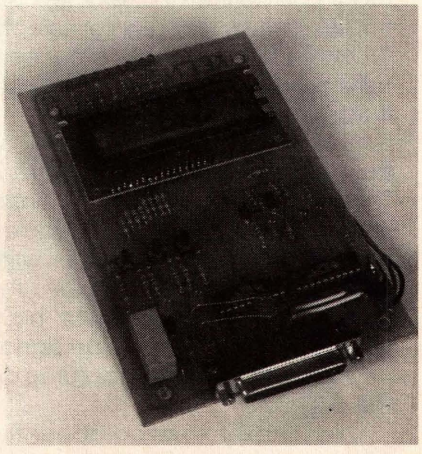
Those simple examples illustrate how easy it is to program the LCD to display messages. All one has to do is to create a list of hexadecimal codes that represent the needed LCD commands and display data, and then dump them through the printer port.

About the Circuit. A complete schematic diagram for a circuit that interfaces an LCD to a printer port is shown in Fig. 1. Note that there is more circuitry than is needed, since it is meant to be an educational tool and demonstrator as much as a practical application.

Power from B1, a 9-volt battery, is regulated by IC3. A voltage divider made from R1 and R2 provides the 0.6-volt differential needed at pin 3 of DISP1 for proper LCD operation.

Signals that pass to and from the printer port are buffered by IC1 and IC2. Together with R19–R26, draining currents from the computer are limited. As we mentioned before, some of the printer-port signals are inverted; transistors Q1 and Q2 reinvert those signals so that writing programs for the LCD will be a bit more intuitive. After all, it's much easier to keep track of "positive" logic (where a logic high is represented by a positive voltage and a logic low by ground).

A set of switches can be read by the computer. Their use depends on what you want to do; they are



The completed LCD interface can be used in ways limited only by your imagination and programming skill.

general-purpose controls that are not committed to any particular function. Note that S1 and RLY1 are connected in parallel. The relay is part of a light-sensing circuit built around R34, a light-dependent resistor. That resistor switches RLY on and off through Q1. The logic is arranged so that the computer sees a logic high when there is light and a logic low in the dark.

Note that each input and output line is monitored by a light-emitting diode. That feature makes the circuit extremely useful in case you have to debug a program.

Construction. The LCD interface circuit is simple enough to be built on a piece of perfboard using standard construction techniques. If you'd like to use a printed-circuit board instead, a foil pattern for a single-sided board has been included here; see Fig. 2. Alternatively, a PC board is available as part of the complete kit described in the Parts List.

If you use a PC board from either the Parts List source or the Fig. 2 foil pattern, use the parts-placement diagram shown in Fig. 3 as a guide to positioning the components. It's a good idea to use IC sockets to avoid any possible overheating during soldering. You also should not install DISP1, IC1, or IC2 until told to do so. Once you have installed all the other parts, check your work carefully for any construction errors such as wrong parts, parts installed backwards, missing components, and poor or missing solder joints. Don't forget the two jumper wires!

Install a fresh 9-volt battery and measure the voltages on pins 2 and 3 of DISP1. Using pin 1 as a reference, you should read close to 5 volts on pin 2 and 0.6 volts on pin 3. Check IC3 and the values of R1 and R2 if your readings are off.

Disconnect B1 and install IC1 and IC2. Plug the unit into a printer port and reconnect B1. Run the program shown in Listing 1 to test the basic connections of the port. Note that this listing assumes your printer port is at address 0378; you should change the value in line 40 as appropriate to your system. If you are not sure of the port's address, consult the manual that came with your computer. On some machines, there is a "boot up" screen that displays various detected hardware before the operating system loads; printer ports are usually listed. If you are running Windows95 or other similar 32-bit operating system, you can find information on the printer port through the Windows "Device Manager;" access it through the Control Panel.

LISTING 1

```
10 REM testing printer 8-bits output port
   address (378 or 3BC)
20 REM turn all 8 LEDs ON by sending
   out all bits=1 (hex FF=binary 11111111)
30 REM turn all 8 LEDs OFF by sending
   out all bits=0 (hex00=binary 00000000)
40 out &h378,&hFF
50 stop
60 end
```

LISTING 2

```
10 REM LCD 16265 display output
   routine
20 REM 2 x 16 characters format
30 REM PRT PORT 378h & 37Ah
   (888 & 890)
100 DEFINT A-Z
110 REM OUT &H303, &H80
115 REM initialization of LCD routine
120 x = &H38: GOSUB 700
130 x = &H1: GOSUB 700
140 x = &H2: GOSUB 700
150 x = &H6: GOSUB 700
160 x = &HC: GOSUB 700
170 PRINT "initialization done"
180 REM routine to monitor light
190 wait 889,8,8
200 REM routine to write line 1
210 x = &H2: GOSUB 700
220 a1$ = "        LCD        "
230 FOR i = 1 TO 16
240 char1$ = MID$(a1$, i, 1)
250 x = ASC(char1$): GOSUB 800
260 NEXT i
300 REM routine to write line 2
310 x = &HC0: GOSUB 700
320 a2$ = "    TECHNOLOGY    "
330 FOR i = 1 TO 16
340 char2$ = MID$(a2$, i, 1)
350 x = ASC(char2$): GOSUB 800
360 NEXT i
370 STOP
380 END
700 REM set1 routine
710 GOSUB 600
720 OUT &H37A, &H2
740 OUT &H378, x
750 OUT &H37A, &H3
760 RETURN
800 REM set2 routine
810 GOSUB 600
830 OUT &H37A, &H6
840 OUT &H378, x
850 OUT &H37A, &H7
860 RETURN
```

The test program should flash LED4–LED11. If it doesn't and you're sure about the printer port's address, trace the signals through the circuit; their path is simple enough.

Once you're satisfied that everything is working, install DISP1.

Software. One of the advantages of using BASIC language is its simplicity and readable structure, making most BASIC programs self-explanatory. The program starts with declarations of LCD settings. The LCD is initialized as an 8-bit, 2-line display unit. The screen is cleared and starts the display at the "home" position to the left of the display. Any characters that are displayed are placed from left to right for each read/write operation. All of the text messages are stored in ASCII code. The input from R34 is continuously monitored for any change; you can add any action that you want with the appropriate programming.

Now that you're familiar with the basic steps in programming an LCD, you'll see that an almost unlimited number of applications exists for this module. For example, you could develop animated text displays or combine the unit with another project. In addition, you could also write control programs in other languages such as Pascal or C. P

Practical PIC Microcontroller Projects

This book covers a wide range of PIC based projects, including such things as digitally controlled power supplies, transistor checkers, a simple capacitance meter, reaction tester, digital dice, digital locks, a stereo audio level meter, and MIDI pedals for use with electronic music systems. In most cases the circuits are very simple and they are easily constructed. Full component lists and software listings are provided. For more information about PICs we suggest you take a look at BP394 -- An Introduction to PIC Microcontrollers.

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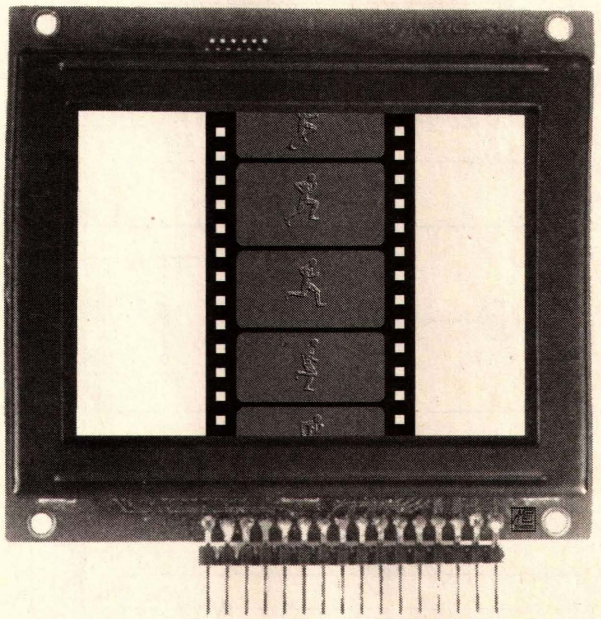
Programming LCD Graphics

Make the messages on your liquid-crystal displays come to life!

MICHAEL CHAN



Intelligent liquid-crystal displays (LCDs) are amazing devices in terms of what they can display, as well as in how easy they are to connect to almost any computer-based system—from the lowliest PIC-based microcontroller circuit to the most powerful desktop computer. Information on how to make those connections has been detailed in the companion article "LCDs for PCs" that appears on page 20 of this issue.

In that article, we studied the basics of connecting a text-based LCD to a computer's printer port and displaying simple text messages, using the programming language selected, be it Basic, Pascal, or C. Now we will show you that producing graphics and animations on a graphics-based LCD is just as easy and can be done for little more than the cost of the LCD display itself. In fact, you probably have most (if not all) of the additional parts needed for this project in your "junk box."

The control concepts and programming procedures are similar for both types of LCDs. If you are familiar with the information presented in "LCDs for PCs," you already know the basics. If not, why don't you take some time and read that article first—we'll wait!

With that knowledge under your belt, you're now halfway to becoming an expert in programming graphic LCD modules. Before you know it, you'll be producing eye-catching LCD displays or even designing your own hand-held games, just like those from the 80s.

Parallel Printer-Port I/O Interface. Like its text-based counterpart, the graphic LCD that we're working with has a built-in intelligent display controller with an interface designed with computers in mind. This time, we're going to need all 12 of the printer port's available output bits as well as an input bit for controlling the LCD module.

Recall that a printer port has three addresses associated with it. Eight of the needed output pins (pins 2–9 of the printer port) are associated with the base address; the four additional output lines (pins 1, 14, 16, and 17) are controlled by the base address + 2. For example, if the printer port is set to address 0378 in hexadecimal notation, the additional pins are accessed through address 037A.

We said that we also need an input pin; we'll use pin 15, which is accessed at the base address + 1 (0379 in the above example).

Keep in mind that in order for the printer port to conform to the Centronics printer-port standard, the signals on pins 1, 14, and 17 are inverted; a logic zero will set those pins to a positive voltage.

TABLE 1
LCD PIN FUNCTIONS

Symbol	Pin No.	Function
/CSA	1	Select right half of screen
/CSB	2	Select left half of screen
V_{ss}	3	Ground
V_d	4	+5-volt power supply
V_o	5	–5-volt power supply
D/I	6	Register select (1=data, 0= instruction)
RW	7	Read/Write (1=read, 0=write)
E	8	Enable data/instruction transfer
DB0-DB7	9–16	Bi-directional data bus

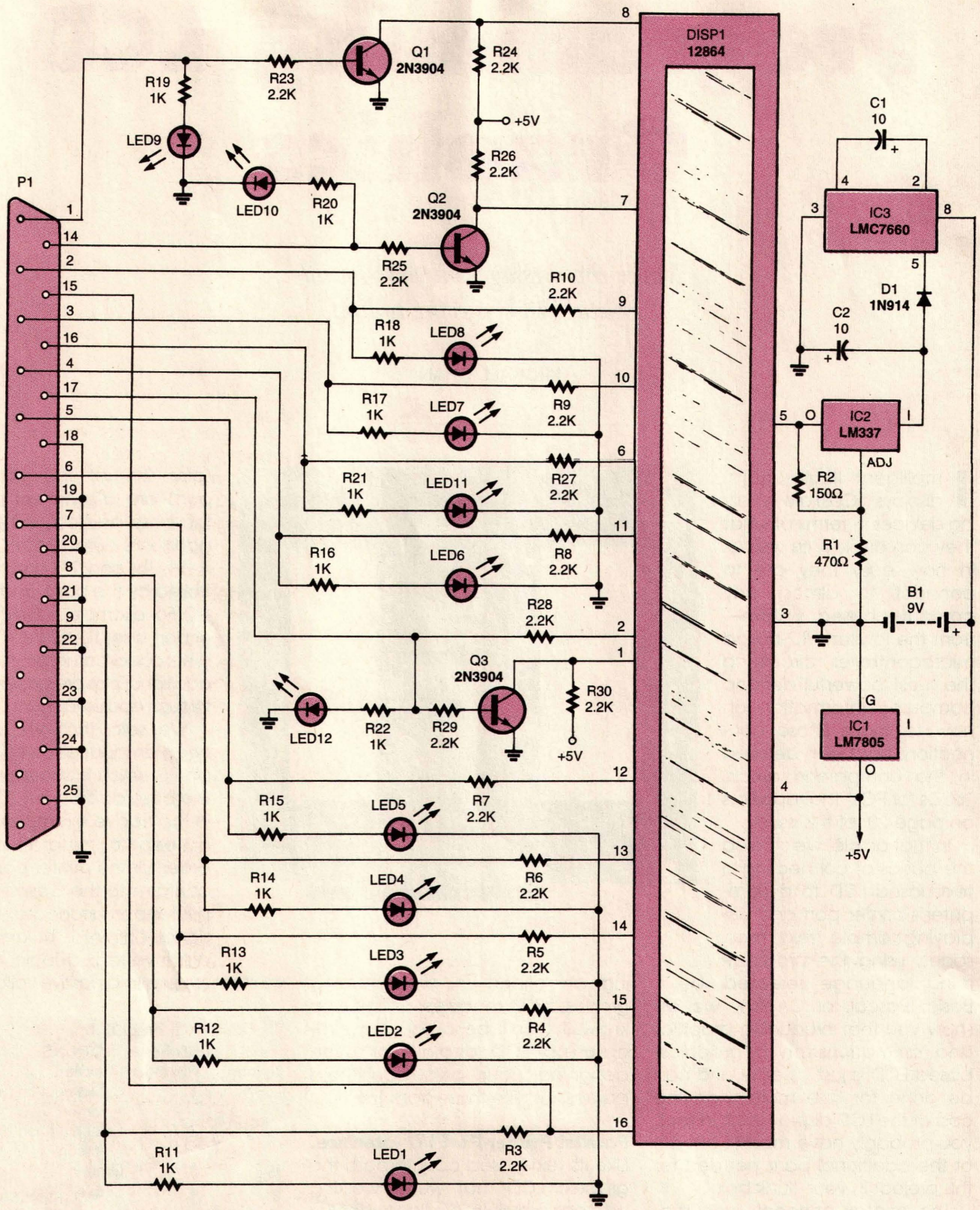


Fig. 1. Connecting a graphic liquid-crystal display to a printer port is easy thanks to the use of sophisticated display-controller chips on the LCD module.

Graphic LCDs. Graphic LCDs come with a great variety of colors, resolutions, and sizes. For our project, we're using a simple 128 by 64 pixel (short for picture element) dot-matrix unit made by Varitronix; their base model number is 12864.

The module's pinout is shown in Table I. Note some of the similarities between this graphic display and the text-based displays that we've worked with before. Functions common to both types of displays include an 8-bit data bus, an enable pin, a read/write control, and a register-select pin. While the graphic LCD also uses three pins for its power supply, one of them is a

TABLE 2
LCD INSTRUCTIONS

Instruction	D/I	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Display On	0	0	0	0	1	1	1	1	1	1
Display Off	0	0	0	0	1	1	1	1	1	0
Display Start Line	0	0	1	1	a	a	a	a	a	a
Set Display Line Address	0	0	1	0	1	1	1	a	a	a
Set Horizontal Address (Auto-increment every R/W cycle)	0	0	0	1	a	a	a	a	a	a
Status Read	0	1	b	0	O/F	R/N	0	0	0	0
Write Display Data	1	0	d	d	d	d	d	d	d	d
Read Display Data	1	1	d	d	d	d	d	d	d	d

Notes:
a=address
d=data
b=busy status
O/F=on/off status
R/N=reset/normal status

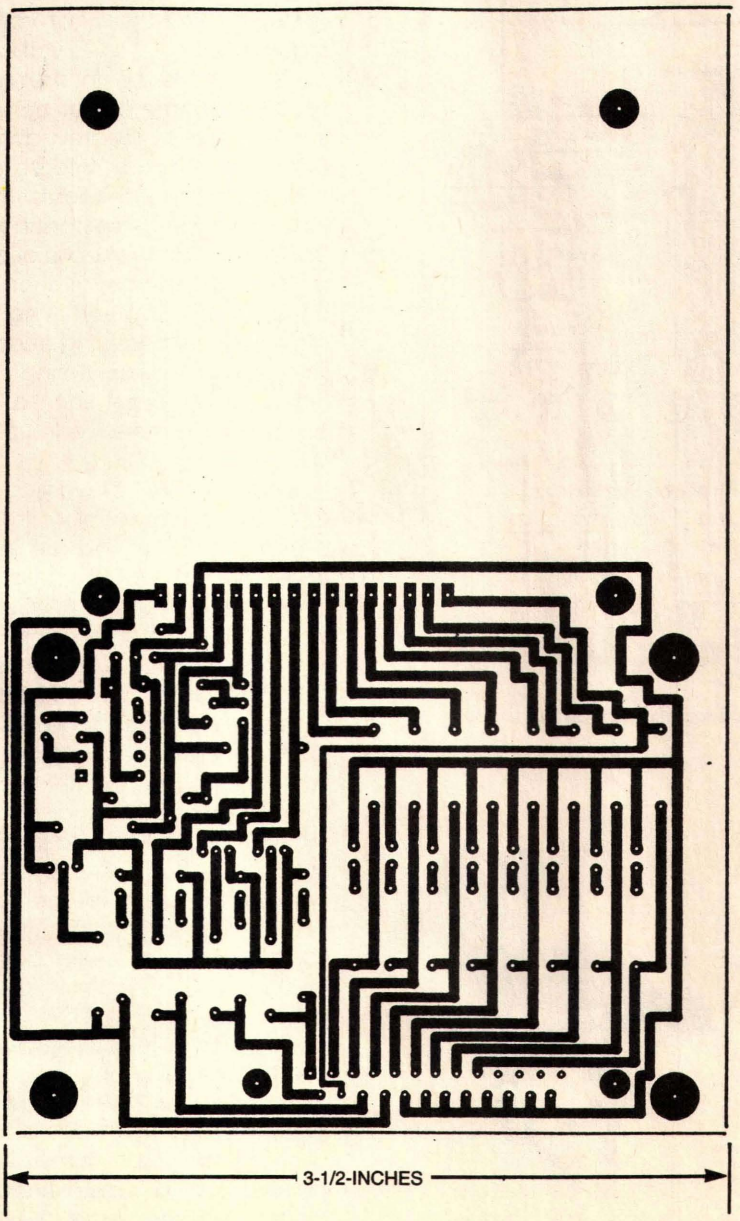


Fig. 2. This foil pattern can be used for making an LCD display unit that can connect to any PC's printer port. Since it has not been etched by the author, you should check it carefully before etching your own board.

negative reference voltage. Two additional control pins select whether the display data is for the left half of the screen or the right half. The LCD is manufactured as two separate devices in one housing; those screen-select pins reflect that design feature.

Like all "intelligent" displays, the 12864 uses a display driver chip to run the module. The Hitachi 61103A is easy to program and command: simply define the starting coordinates on the screen before writing the display graphics in ASCII codes. The instruction sets of the driver are given in Table 2.

Of course, if you would like to use a different LCD, you certainly can. Be advised, though, that you'll have to follow the interface information for whatever display module you select. Different driver chips will have different command codes and read/write sequences.

About the Circuit. A complete schematic diagram for the LCD/Printer Port Interface circuit is shown in Fig 1. A quick comparison between this circuit and the one given for the text-based module shows that they are very similar. The main differences center on the power supply and the printer-port interface.

The circuit requires a split power supply. The obvious way to do that is to use a pair of batteries or a center-tapped transformer. However, we're using a single battery like the text-based circuit. The voltage from B1 is regulated to 5 volts by IC1. The battery also drives IC3, a positive-to-negative voltage converter. That

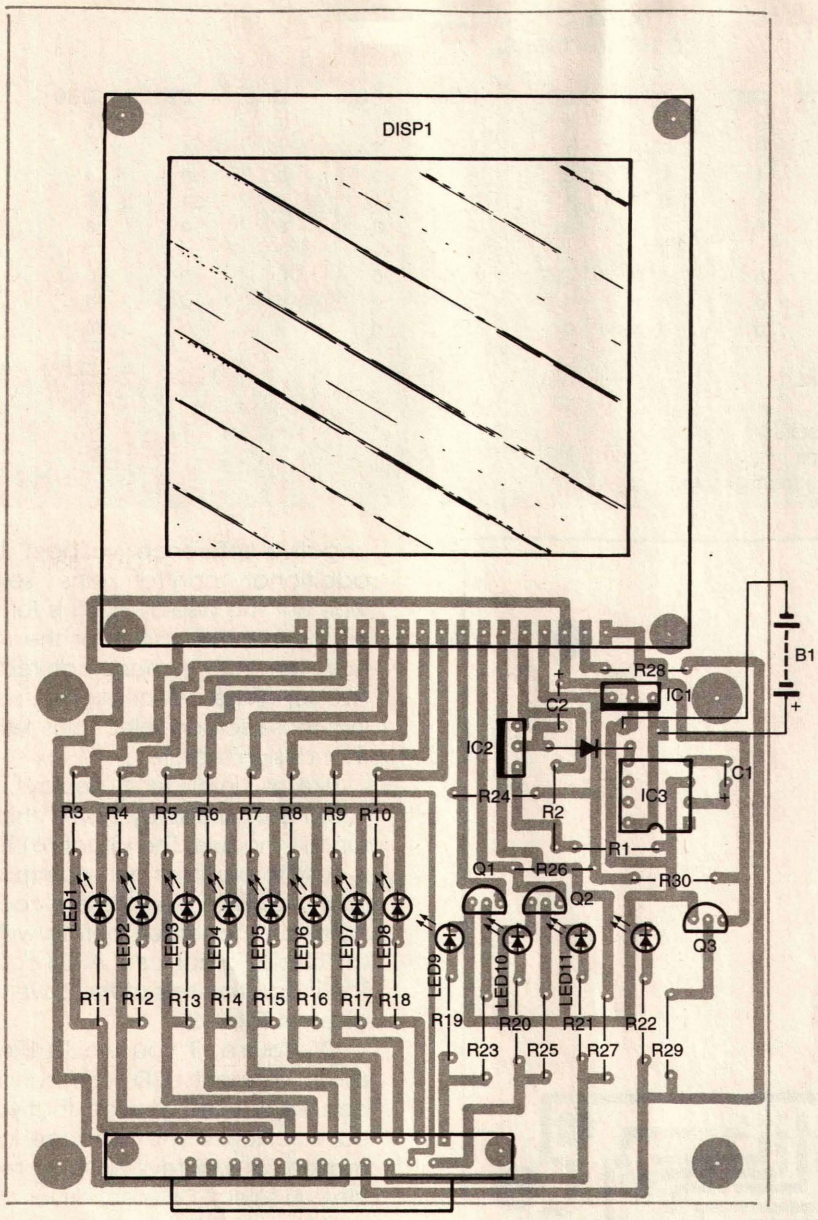


Fig. 3. Here's the parts-placement diagram if you are using the supplied foil pattern to build a graphic LCD display unit for your PC.

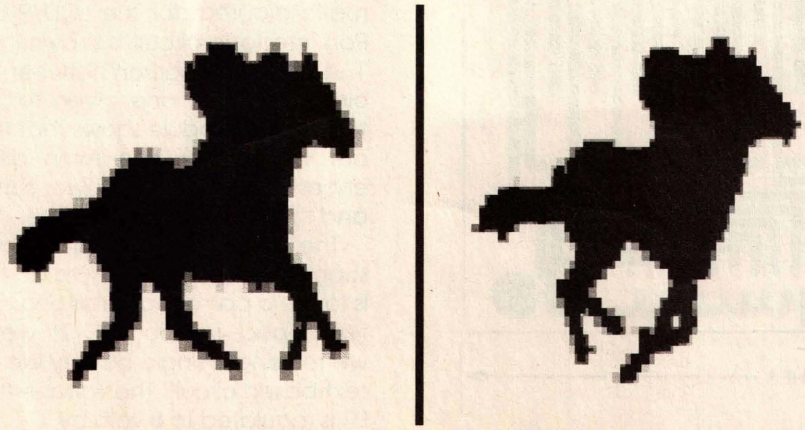


Fig. 4. These two simple pictures form a two-frame animation. When they are displayed one after the other on a graphic LCD, the result is an animation of a running horse.

chip is designed around a phenomenon of capacitors called "ringing overshoot." Simply put, when a capacitor (C1 in the circuit) is charged up to a positive voltage and then discharged quickly, its voltage level will momentarily dip to a negative voltage. Using the time-honored analogy of electricity to water, the action is similar to throwing a rock into a bucket of water; the level of the water will dip before surging up and eventually leveling out.

The induced negative voltage from IC3 is rectified by D1. Capacitor C2 captures the negative voltage spikes and smoothes them out to a pulse-free voltage. That voltage is regulated by IC2 to –5 volts.

One difference in the graphic circuit is that the printer-port signals from P1 are connected directly to DISP1 without any integrated circuits to buffer the signals. There is, however, a set of resistors that helps limit current draw in case of a problem like an electrical short. Each signal has a light-emitting diode with an accompanying current-limiting resistor for monitoring the signal level on each line—a handy addition if you need to troubleshoot the circuit.

One "feature" of working with a Centronics-compatible printer port is that several signals are inverted from what you would expect; that is needed to conform to the Centronics standard. Three of the pins that we use have that inverting feature: pins 1, 14, and 17. For pins 1 and 14, simple transistor switches (Q1 and Q2) are used as inverting gates. While it is not technically necessary to re-invert those signals, doing so makes it much easier to keep track of the needed signal levels when creating programs for the display.

Pin 17 is used to select which half of the screen is being accessed. Transistor Q3 inverts the signal and applies it to pin 1 of DISP1; the non-inverted signal is applied directly to pin 2. That way, only one screen-select signal on DISP1 will be active at a time.

As mentioned before, we use a single input bit to get status from DISP1. A feature of the 12864 LCD is that its "busy" status is output on pin 16 when you read the module's

LISTING 1

```
20 REM Using Printer Port Control
   Program Name:horseart.BAS
30 REM HORSE ROUTINE 8x16 (8x8
   DOT) blocks LCD 12864
110 DEFINT A-Z
120 DIM dataset(44, 8)
140 REM 44 screen patterns in ASCII
   codes
150 DATA &H00,&H00,&H00,&H00,&H00,
   &H80,&HC0,&HF0
170 DATA &HF8,&HF8,&HF8,&HFC,
   &HFC,&HFC,&HFC,&HF8
190 DATA&HFC,&HFE,&H7E,&H7,&H7E,
   &H18,&H80,&H80
210 DATA &H80,&H80,&H80,&H80,&HC0,
   &HC0,&HE0,&HE0
230 DATA &HE0,&HC0,&H80,&H00,&H00,
   &H00,&H00,&H00
250 DATA &H00,&H00,&H00,&H00,&H00,
   &H80,&H80,&H00
270 DATA &H00,&H00,&H00,&H00,&H00,
   &H00,&H00,&H80
290 DATA &H80,&H80,&HC0,&HC0,
   &HC0,&HE0,&HE0,&HC0
310 DATA &HC0,&HC0,&HC0,&HC0,
   &HE0,&HE0,&HE0,&HF0
330 DATA
&HF0,&HF0,&HF0,&HE0,&HE0,
&HC0,&HC0,&H80
350 DATA &H00,&H80,&H8C,&H3F,&H3F,
   &H7F,&H7F,&HFF
370 DATA &HFF,&HFF,&HFF,&H2F,&H0F,
   &H8F,&HCF,&HEF
390 DATA &HF7,&HFF,&HFE,&HFE,
   &HFE,&HFD,&HFE,&HFE
410 DATA &HFF,&HFF,&HFF,&HFF,&HFF,
   &HFF,&H3F,&H7F
430 DATA &H7F,&H7F,&H7F,&H7F,&HFE,
   &HFC,&HF8,&HE0
450 DATA &HC0,&H00,&H00,&H00,&H00,
   &H00,&H00,&H00
470 DATA &H00,&H00,&H00,&H00,&H00,
   &H01,&H0B,&H0B
490 DATA &H0F,&H2F,&H3F,&H3F,&H3F,
   &H5F,&H7F,&H7F
510 DATA &HBF,&HDF,&H7F,&H7F,&H3F,
   &H1F,&H0F,&H07
530 DATA &H03,&H3F,&HFF,&HFF,&HFF,
   &HFF,&HFF,&HFF
550 DATA &HFF,&HFF,&HFF,&HFF,&HFF,
   &HFF,&HFF,&HFF
570 DATA &HFF,&HFF,&HFE,&HFF,&HFF,
        &HFF,&HFE, &HFE
590 DATA &HFF,&HFF,&HFF,&HFF,&HFF,
   &HFF,&HFE,&HFF
610 DATA &HFF,&HFF,&HFF,&HFF,&HFF,
   &HFF,&HFF,&HFF
630 DATA &HFF,&HFF,&HFF,&H3F,&H0F,
   &H01,&H00,&H00
650 DATA &H00,&H00,&H00,&H00,&H00,
   &H00,&H01,&H01
670 DATA &H00,&H00,&H00,&H00,&H00,
   &H00,&H00,&H00
690 DATA &H00,&H00,&H04,&H00,&H00,
   &H00,&H00,&H00
710 DATA &H00,&H00,&H00,&H00,&H01,
   &H03,&H67,&H6F
730 DATA &HFF,&HFF,&HFF,&HFF,&HFF,
   &HFF,&HFF,&HFF
750 DATA &HDF,&H0F,&H07,&H0F,&H0F,
   &H1F,&H1F,&H1F
770 DATA &H3F,&H3F,&H3F,&H3F,
   &H3F,&H3F, &H3F,&H7F
790 DATA &HFF,&HFF,&HFF,&HFF,&H7F,
   &H7F,&HFF,&HFF
810 DATA &HFF,&HF3,&HE0,&HE0,&HC0,
   &H80,&H80,&H00
830 DATA &H00,&H01,&H01,&H03,&H07,
   &H07,&H0F,&H0F
850 DATA &H1F,&H3F,&H7E,&HFC,&HFC,
   &HF8,&H62,&HC6
870 DATA &H8C,&H0C,&H0C,&H18,&H18,
   &H18,&H30,&H70
890 DATA &H73,&H77,&H7F,&H3F,&H00,
   &H00,&H00,&H80
910 DATA &HC0,&HE1,&H31,&H39,&H1D,
   &H0F,&H0F,&H03
930 DATA &H00,&H00,&H00,&H00,&H00,
   &H03,&H1F,&H3E
950 DATA &H7B,&HC7,&HCE,&H98,
   &H30,&H70,&H60,&H40
970 DATA &H00,&H00,&H00,&H00,&H00,
   &H03,&H03,&H01
990 DATA &H00,&H00,&H01,&H01,&H00,
   &H00,&H00,&H00
1010 DATA &HFF,&HFF,&HFF,&HFF,&HFF,
   &HFF,&HFF,&HFF
1015 slow = 80
1020 FOR i = 1 TO 44
1030 FOR j = 1 TO 8
1040 READ dataset(i, j)
1050 NEXT j
1060 NEXT i
1070 SET$ = "ABCDEFGHIJKLMNO
   PQRSTUVWXYZ .abcdefghijklmnp~"
1080 message$ = "                "
1082 message$ = message$ + "
   ABCDE    "
1084 message$ = message$ + "
   FGHIJKLMNOP              "
1086 message$ = message$ + " QRSTU
   VWXYZ          "
1088 message$ = message$ + "    abcdef
   "
1090 message$ = message$ + "    ghijk
   "
1092 message$ = message$ + "    lmn
   "
1094 message$ = message$ + "    p
   "
1130 REM CLEAR SCREEN
1140 Y = 0: K = 0: n = 0
1150 FOR j = 0 TO 1023
1160 IF n <> 0 + K GOTO 1220
1170 x = 0 + Y
1180 p = 8
1190 q = 0
1200 GOSUB 1750
1210 GOTO 1270
1220 IF n <> 64 + K GOTO 1270
1230 p = 16
1240 GOSUB 1750
1250 K = K + 128
1260 Y = Y + 1
1270 a = 0
1280 GOSUB 1870
1330 n = n + 1
1340 NEXT j
1350 REM 8x8 dot graphic matrix
   GENERATION
1360 Y = 0: K = 0: n = 0
1370 FOR j = 1 TO 128
1380 char$ = MID$(message$, j, 1)
1390 FOR jj = 1 TO 44
1400 IF char$ = MID$(SET$, jj, 1) GOTO
   1440
1410 NEXT jj
1440 FOR i = 0 TO 7
1460 IF n <> 0 + K GOTO 1520
1470 x = 0 + Y
1480 p = 16
1490 q = 0
1500 GOSUB 1750
1510 GOTO 1580
1520 IF n <> 72 + K GOTO 1580
1530 p = 8
1540 q = 0
1550 GOSUB 1750
1560 K = K + 144
1570 Y = Y + 1
1580 a = dataset(jj, i + 1)
1590 GOSUB 1870
1600 IF jj = 27 GOTO 1640
1640 n = n + 1
1650 NEXT i
1680 n = n + 1
1700 NEXT j
1730 END
1740 STOP
1750 REM SUBROUTINE Instruction
1760 B = 0
1770 a = &H3F
1780 GOSUB 1870
1790 a = &HC0
1800 GOSUB 1870
1810 a = &HB8 + x
1820 GOSUB 1870
1830 a = &H40 + q
1840 GOSUB 1870
1850 B = 4
1860 RETURN
1870 REM SUBROUTINE Print
1890 OUT &H37A, 2 + p
1900 OUT &H37A, 3 + p
1910 C = INP(&H379)
1920 OUT &H37A, 2 + p
1930 C = C AND &H8
1940 IF C = 0 GOTO 1970
1950 PRINT "busy"
1952 FOR kk = 1 TO slow
1954 kkk = kkk + kkk
1956 NEXT kk
1960 GOTO 1890
1970 OUT &H378, a
1990 OUT &H37A, B + 1 + p
2000 OUT &H37A, B + p
2010 RETURN
```

PARTS LIST FOR THE GRAPHIC LCD DISPLAY

SEMICONDUCTORS

IC1—LM7805 fixed positive 5-volt regulator, integrated circuit
IC2—LM337 adjustable negative 5-volt regulator, integrated circuit
IC3—LMC7660 positive-to-negative voltage converter, integrated circuit
Q1-Q3—2N3904 NPN silicon transistor
LED1–LED12—Light-emitting diode, any color
D1—1N914 silicon switching diode

RESISTORS

(All resistors are 1/4-watt, 5% units.)
R1—470-ohm
R2—150-ohm
R3–R10, R23–R30—2200-ohm
R11–R22—1000-ohm

ADDITIONAL PARTS AND MATERIALS

B1—9-volt battery
C1, C2—10-µF, 16-WVDC, electrolytic capacitor
DISP1—12864-series 128- by 64-pixel dot-matrix liquid-crystal display (Vartronix MSD12864 or similar)
P1—25-pin D-subminiature style connector
9-volt battery clip, wire, hardware, etc.
Note: The following item is available from Keen Designs, 16 Gennela Square, Scarborough, Ontario, M1B 5A6, Canada; Web: *www.geocities.com/SiliconValley/Foothills/1897*: Tutorial sample programs on disks, $10 ($15 Canadian). Canadian residents must add appropriate GST and PST.

status. That bit can be monitored individually through pin 15 of P1.

Construction. The Fig. 1 circuit is simple enough to build on a piece of perfboard using standard construction techniques. For those that would like to use printed-circuit techniques, a foil pattern for a PC board is given in Fig. 2. While the supplied foil pattern appears to be accurate, it has not been built by the author, and its accuracy is not guaranteed; use it at your own risk.

A parts-placement diagram for the Fig. 2 foil pattern is shown in Fig. 3. A socket is recommended for IC3 to protect it from overheating during soldering. Do not install DISP1 until the rest of the circuit has been tested under power; the module is an expensive component and can easily be damaged.

Power up the circuit and check for 5-volt levels from IC1 at the various points of the circuit where it should appear. With power off, install IC3 and re-apply power. Check for a negative voltage between -5 and -6.5 volts on pin 5 of DISP1.

Plug the circuit into a printer port and use a program in the selected language of your choice (Basic, Pascal, C, Fortran, etc.) to write data to the various printer-port addresses; the LEDs should switch without shorts or other miswirings. Details on one suggested Basic program can be found in the companion article that we've mentioned before.

With the circuit tested and working, install DISP1; you're now ready to program your first picture.

Graphics Design. Unless you are a talented artist, it takes time and trial and error to produce a good picture. One suggested technique is to use a 128-column by 64-row grid to represent the pixels that are available on the LCD. By filling in the blanks, you can create any artistic design that suits your needs. Once you have an appropriate pattern, it is just a matter of grouping the dotted pattern into 8-bit bytes that are then dumped onto the LCD in the proper sequence. Animations could be achieved by writing different motion scenes repeatedly on the screen. An example of a two-frame animation is shown in Fig. 4. That animation is the basis of the included sample program that we'll discuss next.

A Simple Animation. Listing 1 contains a sample program that creates the two-frame animation depicted in Fig. 4. The program starts with declarations of LCD settings. It turns the display on and defines the starting coordinates on the screen. The program then reads the data that represents the first graphic frame and dumps it to the LCD. Another scene is then loaded and written on top of the existing scene to produce an animated effect. That sequence is repeated over and over.

The program works on PCs from XTs up to about a 120-MHz Pentium-based machine. For higher-end computers, you might have to adjust or add some time-delay routines to accommodate the speed at which the LCD hardware can digest instructions and display data.

Now that you've seen how to connect a graphic LCD to a printer port, you can appreciate that with today's intelligent LCDs it is simple enough for anyone to do, yet it could be a stepping stone to producing eye-catching graphics. This hot technology not only entertains the inquiring minds of hobbyists but also opens the door to a potential career in games, visual aids, and electronic advertising. P

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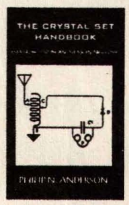

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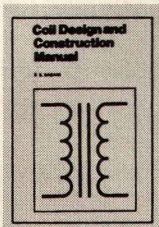

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SERVICE CLINIC

SAM GOLDWASSER

Keeping Your VCR Happy

This month we start off with some basic non-repair-related information that could potentially prevent major problems in the future. The location of the VCR and what it's fed, as well as preventive maintenance can make a big difference in its (and your) happiness.

General VCR Placement Considerations

Proper care of a VCR does not require much. Following the recommendations below will ensure its long life and minimize repairs:

- Allow adequate ventilation. While VCRs are not huge users of power, there is some heat buildup. Leave at least 1–1.5 inches around all sides and around the top for air circulation. Try not to place the VCR near heat-producing equipment.
- Do not put anything on top of the VCR that might block the ventilation grill. To be safe, don't put anything on top, period. Tapes left there, for instance, will tend to age prematurely from heat and magnetic fields. In addition, modern VCRs are *not* built like the Brooklyn Bridge! The weight of a TV or of stereo components could affect the VCR mechanically, messing up tape path alignment or worse.
- If possible, locate the VCR away from the TV. Some VCRs are particularly sensitive to interference from the TV's circuitry; and while this won't usually damage anything, it may make for less than optimal performance.
- Don't locate VCRs in dusty areas if possible. If you can't find a clean place to keep it, the unit should be protected with a dust cover when not in use.
- Don't keep VCRs in areas of high tobacco smoke or cooking grease vapors. I cannot force you to quit smoking, but it is amazing how much disgusting, difficult-to-remove brown grime is deposited on sensitive electronic equipment in short order from this habit.
- Make sure all input/output video and audio connections are tight and secure to minimize intermittent or noisy pictures and sound.
- Finally, store videocassettes well away from all electronic equipment (especially loudspeakers). Again, heat and magnetic fields are dangerous to tapes and could rapidly turn your priceless video collection into so much trash. It is also recommended that you store the cassettes on edge and that you run them through a VCR or winder/ rewinder from start to end and back using FF and REW at least once a year (another pair of recommendations that are rarely followed).

Videotape Quality

When shopping for blank tapes, avoid brands you've never heard of or generic store brands like those offered by K-Mart and Blockbuster, for instance.

As for the name brands, higher-grade tapes are not necessarily worth the expense, but in my experience with some like Maxell and Scotch tapes, going one level up from the cheapest is worthwhile and results in a noticeably better picture. Only a few companies actually manufacture the raw tape stock.

The higher grade tapes may actually be harder on the video heads due to their formulation, but this probably doesn't matter for the ordinary user. You don't need HiFi grade tapes for HiFi—any tape will work. However, higher-grade tapes may last longer with higher quality results in demanding situations such as the recording of 24-hour-a-day security monitoring.

Tape Rewinders

Should you buy a tape rewinder to save wear and tear on your VCR? Take it or leave it. I think they are good if your VCR is old and for whatever reason has trouble when you hit FF or REW. However, sluggish performance of either of these high-speed modes may be a precursor to tape eating and should be addressed to avoid an impending failure that may ruin a tape. Rubber parts deteriorate by just existing. Their surface layers oxidize and use may actually be good for these parts.

I would not bother with a rewinder just to prevent wear and tear on the motors or heads. In many VCRs—particularly older units without real-time tape counters—the tape is totally retracted into the cassette during high-speed fast-forward or rewind and does not contact the heads at all. As for newer VCRs with real-time counters, the tape will contact the control head lightly but wear should not be worth worrying about.

Even in some high-performance VCRs where video heads remain in contact with the tape during rewind, the wear is not significant. This is due to the fact that the heads spin rapidly, and wear isn't much different between normal play/record modes and fast rewind. It is the total time that matters for head wear, and rewind time is minimal. In addition, some VCRs reduce the tape tension during fast rewind as a further precaution.

In more detail, assuming a three-minute rewind time for a T-120 tape (total tape length 240 m), the linear tape speed for FF or REW is 80 m/minute or 1.333 m/s. Relative video-head tape speed in normal play is about 4.83 m/s, and the 1.333 m/s gets added (during rewind) or subtracted (during fast-forward) from 4.83 m/s. So, assuming the machine is properly adjusted, this is similar to an equivalent length of time in normal play and is really negligible.

Of course, if the convenience of being able to rewind off-line is important to you, then there may be no harm in using a rewinder. Keep in mind, though, that some rewinders can be hard on videotapes as they usually do not sense the clear leader but stop rewinding when the tape tension increases at the

end of the tape. This may eventually damage the tape and/or pull the tape from the takeup reel hub. I have heard of some units crinkling tape edges and actually mangling tapes.

Rental-Tape Considerations

It would be nice for your VCR if rental movies had never been invented. You have no idea of the history of any tape you bring home. The following may also apply to tapes in your video library or tapes given to you by friends or relatives:

- The tape may be old and old tapes shed a lot more oxide and crud than newer tapes. A single playing may clog your video heads.
- The tape may have been damaged by a prior viewing and one pass through may ruin your expensive video heads. A tape that has been seriously crinkled due to a VCR tape-eating incident and then wound back into the cassette may be a ticking time bomb for your VCR. A tape with a partial break or one that has been improperly spliced is even more likely to cause serious damage.
- The cassette mechanism itself may have been damaged (from being dropped or stored in a hot automobile) with unknown consequences for your VCR.

Note: if you should ever damage a rental tape as a result of a cranky VCR or for any other reason, don't just give it back to the video store. Please let them know. Also, if your VCR should jam with a tape inside, do not forcibly extract it. Let the video store know what happened and follow their recommendations.

Some problems can be avoided by fast-forwarding a couple of minutes into the tape before hitting PLAY, as damage to rental tapes often occurs near the start. Hitting FF here will avoid some of the useless coming attractions as well!

And if you notice the video breaking up or deteriorating while you are watching, immediately eject the tape as the worst may be yet to come!

While I cannot control your viewing habits, playing a lot of old, dirty, deteriorated tapes (rental or from your own tape library) will eventually take a toll on your VCR. If you do watch these dangerous types of tapes often, at the very least you should perform a general cleaning and inspection at more frequent intervals.

Preventive Maintenance (PM)

You no doubt have heard that a VCR should be cleaned and checked periodically. This is basically good advice but few people follow it. I cannot give a specific schedule to follow as many factors influence the amount of wear and tear on your VCR:

- If you mostly use new brand-name tapes to make your own recordings, rarely play rental tapes, and have the VCR located in a clean cool relatively dust-free and smoke-free location, you may be able to go 5 years with no problems. However, a more prudent interval would be 1-2 years between preventive maintenance and rubber replacement after 4-5 years. Obviously, if you record programs every evening or have frequent marathon viewing parties you should probably reduce the maintenance interval.
- If you play rental movies or older tapes every weekend and have chain smokers in the house, every 3 months may not be frequent enough. I would suggest 6 months to 1 year between preventive maintenance and recommend that you consider rubber replacement after 3-4 years.

Realistically, you are not going to do any PM anyway. So, just be aware of the types of symptoms that would indicate the need for cleaning or other preventive or corrective maintenance. Watch for erratic loading, a resistance to performing certain operations, whirring motors without cycle completion, sluggish entry or exit from particular modes, jittery or noisy picture, or wavering or muddy sound.

If you do perform an inspection and find deteriorated rubber parts, obviously these should be replaced regardless of their age.

Of course, acute symptoms like tape-jam or tape-munching episodes are signs of the need for emergency treatment. This still may mean that a thorough cleaning is all that is needed.

I generally don't consider head-cleaning tapes to be of much value for preventive maintenance since they do not run long enough or with enough force to clean the rollers, stationary heads, and guide posts. Also, the dry type in particular is abrasive and frequent use may cause premature wear to the expensive video heads.

The following are just some reasons to inspect and clean your VCR periodically:

- This will maintain performance at factory/new levels. Dirt, dust, and shed tape oxide all contribute to a reduction in stable tape movement and to possible problems with noisy or jumping pictures and muddy or wavering sound.
- Dirt, dust, and other crud can be deposited on the tapes you run through the VCR, contaminating them and passing problems on to this or other VCRs in the future.
- Your inspection will reveal if service parts like belts, tires, the pinch roller, etc. are in good conditions so that future surprises will be minimized.

If you follow the instructions we will provide next time for VCR cleaning and rubber parts replacement, there is minimal risk to the VCR. However, don't go overboard. If the belts are in good condition (by appearance and stretch test), just clean them or leave them alone. This is especially true in the (generally infrequent) designs of some models of VCR tape transports where significant disassembly is required to replace a belt. In this situation, you risk not being able to put everything back the way it was. Most belts can be replaced with little or no disassembly beyond removing the top and bottom covers and possibly any circuit boards that may be in the way. Sometimes one or two additional screws will need to be loosened or removed to move a bracket or shield.

Most Common Problems

Watch out for the following:

- VCR refuses to fast-forward or rewind and shuts off.
- VCR shuts off entering play or record modes or at random during either mode.
- VCR eats tapes.
- VCR doesn't accept tapes or ejects them without cause.
- Sound is wavering, fluctuating, or muddy.

The cause for all of these is very often a bad idler tire or other dirty, worn, or tired rubber parts. A VCR that just munched down your favorite tape is very likely only in need of a little tender loving care.

Warning: Don't turn a simple repair into a full-length double feature. Most tires and belts come off without extensive disassembly. However, if your VCR is the exception, *do not* remove anything to get at the rubber part that may be part of a critical timing relationship (racks or gears, for example) before fully understanding the implications of this action. In some cases, if a gear is rotated even one tooth from where it should be, there can be unforeseen and catastrophic con

(Continued on page PR-3)

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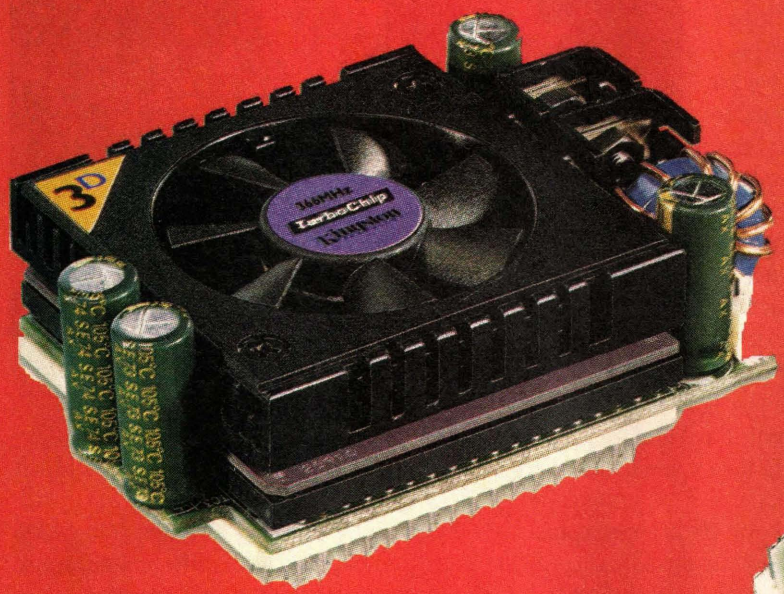
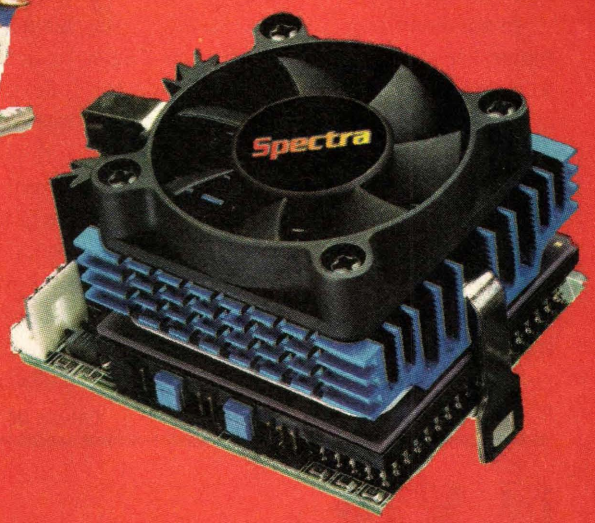
Upgrading a CPU.....39





DEPARTMENTS

PC GIZMO.....36
Memory Stick products, revamped MP3 player, SuperDisk camera, and more

SYSTEM DESIGN.....38
Micron Millennia Max 533B

PEAK COMPUTING.....43
A Combo Video Upgrade—MPEG-2, TV, and Killer Graphics

COMPUTER BITS.....45
PC-Generated Ink Stamps

NET WATCH.....52
Browser Timesavers

PC GIZMO®

Sony's Data-Sharing Family

Whatever the multimedia application, there's a good chance Sony's got a product that can handle it. No big surprise, considering the electronics giant's dominating presence in the industry. What may cause you to raise an eyebrow, though, is Sony's new *Memory Stick* media ($30–$190, in 4–64MB capacities), which lets many of the vendor's products work together. Since its inception last year, the storage medium has attracted the attention of a couple dozen other companies that want to license the technology in their own products. Soon Aiwa, Oki, Pioneer, and Sharp, to name a few, will be offering Memory Stick products.

In the Sony family alone, however, the choices are many. For starters, your machine will have to be able to accept the media. Most new Sony *VAIO* desktops and laptops come with Memory Stick slots, but the vendor also offers three *Memory Stick Adapter* models that work via the following interfaces (all street prices): floppy disk ($99), parallel port ($89), or PC Card ($79).

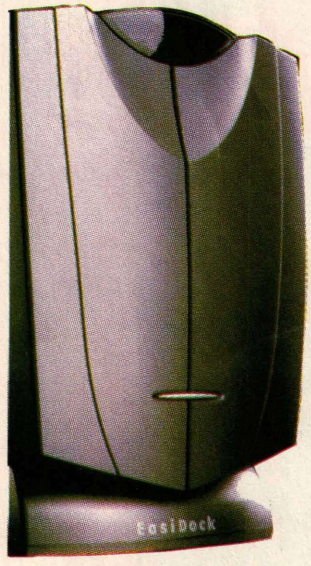
Audio buffs can put the media to good use with the *Memory Stick Walkman* ($399) that can play secure or copyrighted MP3 files. Another audio application is to take voice notes on the *Memory Stick Voice Recorder* ($299), which can store 131 minutes of speech on 16MB media.

On the visual side, check out the *Cyber-shot* ($999) 2.1-megapixel digital camera or the *Digital Video Handycam* ($1999), which can handle still and motion video. To proudly display the shots you capture with either camera, use the *CyberFrame* ($899) LCD display or *Memory Stick Printer* ($499), which lets you print without a computer.

Sony Electronics Inc., 1 Sony Drive, Park Ridge, NJ 07656; 800-222-SONY; *www.sony.com.*

CIRCLE 90 ON FREE INFORMATION CARD

Dock Any Laptop



Mobile computers can be expensive, which is why many users tend to make their laptops their only systems. But if you want to dock this little wonder to a monitor, printer, and other peripherals when you're at your desk, you're stuck with whatever docking solution your portable's vendor offers, even if it doesn't fully suit your needs. Further, when you get a new notebook, you'll have to invest in a new dock.

Mobility Electronics' new *EasiDock 3000* ($499) might be just the answer to this aggravating and costly dilemma. Just slide the PC Card connector at the end of EasiDock's cable into your laptop's Type II slot, and it's connected. Unlike previous PC Card-interface stations, the EasiDock 3000 allows for video passthrough, which means you can have a monitor connected to the dock.

Also inside the tower station is 10/100 Ethernet, two bays for disk or ROM drives, an EIDE interface, and two PCI slots. In addition to the SVGA and Ethernet connections, on the back of the EasiDock you'll find parallel, serial, PS/2-keyboard, PS/2-mouse, and two USB ports. In short, everything you need is there to use your notebook like a desktop, regardless of what notebook you will ever own in the future.

Mobility Electronics, Inc., 7955 East Redfield Road, Scottsdale, AZ 85260; 480-596-0061; *www.easidock.com.*

CIRCLE 91 ON FREE INFORMATION CARD

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A Graphics Tablet/Mouse Combo

You don't have to be a graphic artist to take advantage of Wacom's new *Graphire* tablet ($99, MSRP), though it may turn you into one. The easy-to-use, USB peripheral combines the best of traditional pointing technologies with the ability to create pressure-sensitive drawings onscreen.

For day-to-day pointing and clicking, rest on the tablet the included cordless mouse and use it as you would any other techno rodent. Well, minus the cleaning and slipshod tracking, that is ... the Graphire mouse has no rolling ball and it features three times the resolution of traditional mice.

But when you want your creativity to soar, pick up the pressure-sensitive pen and feel free to draw with realistic strokes. The 512 levels of detectable pressure also come in handy if you want to sign documents with a natural-looking John Hancock. An included software bundle makes a world of pen-and-tablet applications available.

Wacom Technology Corp., 1311 SE Cardinal Court, Vancouver, WA 98683; 800-922-9348; *www.wacom.com.*

CIRCLE 92 ON FREE INFORMATION CARD

Portable MP3 Player Revamp

Since Diamond released the first portable MP3 player, a flood of similar products from other companies has hit the shelves. However, in many ways, Diamond still has the market cornered.

The newest version of the popular player, the *Rio 500* ($269, street) offers several features that make it the leader of the pack. First there's the fast interface. With the included USB cable, you can load songs into the unit at about five times the rate of a parallel-port connection. USB also makes the Rio 500 the first player to be accessible to both PC and Mac users.

Then there's the decoding capabilities. Fans of MP3 know that files encoded with variable bit rate (VBR) sound better than ones made at constant bit rate (CBR). The former allows the MP3 encoder to adjust compression depending on how "dense" each passage of audio is; but until now, portable players couldn't decode primo VBR files. The Rio 500 can handle either type of file, encoded at anywhere from 16–320 Kbps.

How much does it hold? The unit's built-in 64MB of memory can handle about two hours of 128-Kbps audio or 32 hours of spoken-word recordings. There are also internal expansion slots that can currently add another 32MB in the form of a Smart Media card (as the capacities of these go up, you'll have that much more storage in your Rio 500). You'll make use of the capacity, too, as the unit will provide 13 hours of play with a single AA alkaline.

Best of all, though, with its customizable bass and treble EQ, the Rio 500 sounds great.

Diamond Multimedia, S3 Inc., 2841 Mission College Boulevard, Santa Clara, CA 95054; 408-588-8000; *www.diamondmm.com.*

CIRCLE 93 ON FREE INFORMATION CARD

SuperDisk Digital Camera

As great as the new types of solid-state media are, it will take them a long time to achieve the ubiquity and low prices that floppy disks have. Every PC can read them, and some newer machines can even use the much-improved 120MB floppy or SuperDisk. Panasonic is banking on these two facts of floppy-disk prevalence (particularly the latter) with its *PalmCam SuperDisk* digital camera ($999, MSRP).

The new 1.3 million-pixel camera allows users to store up to 1500 images on a single SuperDisk (depending on the compression used) or up to 17 shots on a standard floppy. Once you're sure you've gotten the photos you wanted by checking them on the camera's 2.5-inch LCD screen, you can easily transfer them on the disk to a PC for use in e-mail, Web pages, or any other application. It can't get easier than this.

Panasonic Consumer Electronics Company, One Panasonic Way, Secaucus, NJ 07094; 800-211-PANA; *www.panasonic.com.*

CIRCLE 94 ON FREE INFORMATION CARD

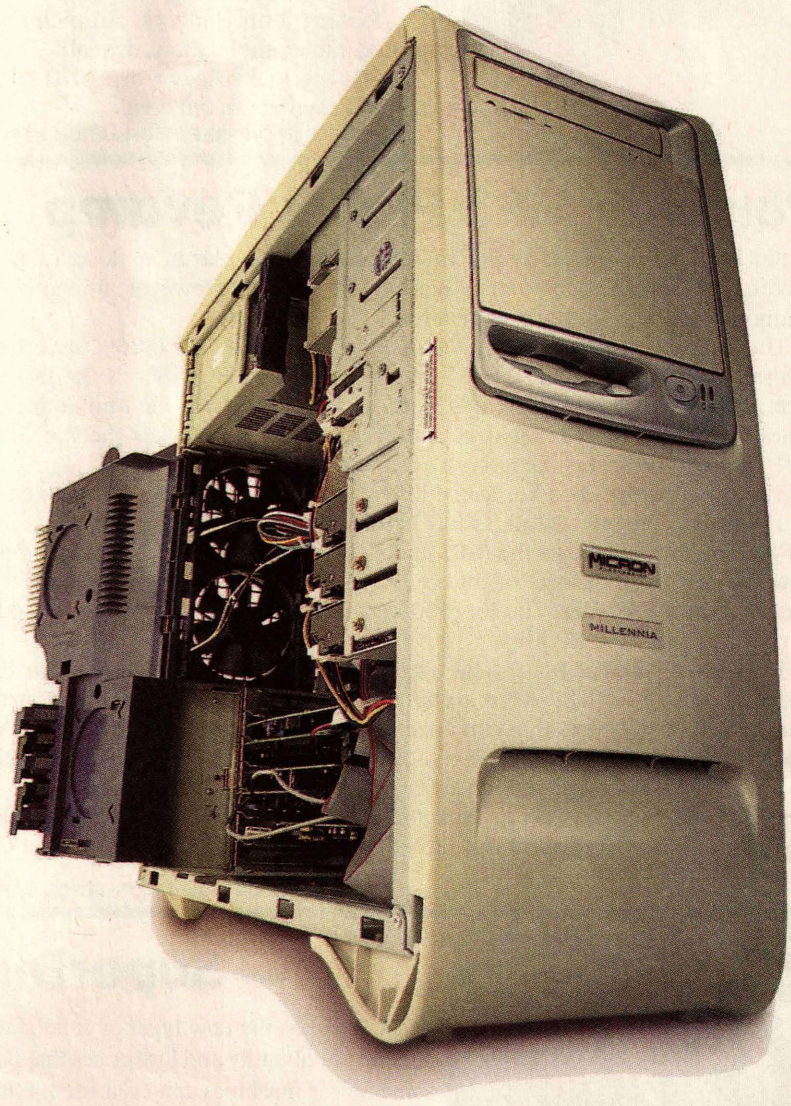
SYSTEM DESIGN

TED NEEDLEMAN

MICRON MILLENNIA MAX 533B

Back in October 1999, Intel introduced a new series of Pentium III CPUs. These were not just faster processors (in fact, some of the CPUs introduced were actually the same speed as existing Pentium IIIs), but were actually based on a new fabricating process. This .18-micron fabrication process, which permits smaller objects to be constructed on the CPU die, has a number of benefits. The Pentium IIIB can fit 28 million transistors on the die, compared to the 9.5 million from the .25-micron fabrication process used in the earlier version of the Pentium III. Obviously this increases performance of the new Pentium IIIB, measured against the same clock-speed version of the prior PIII CPU. It also allows the PIIIB to use somewhat less power. Finally, a new Level 2 cache design, called an Advanced Transfer Cache, has been implemented in the most recent Pentium III release, which comes in clock speeds up to 733-MHz.

Intel was also supposed to release a brand-new core logic chipset, the 820, at the same time. The 820 will provide support for a faster front-side system bus; and it will be able to handle new, faster types of RAM, including PC133 and RAMBUS memory. Unfortunately, the 820 chipset experienced problems that caused a delay in its release. Numerous PC vendors had released pre-production units to the PC press, who usually work under a 3- or -4 month lead-time. These vendors found themselves in the embarrassing position of having computer magazines pull reviews of new PIIIB/820-based systems because of the delay.



MICRON'S SOLUTION

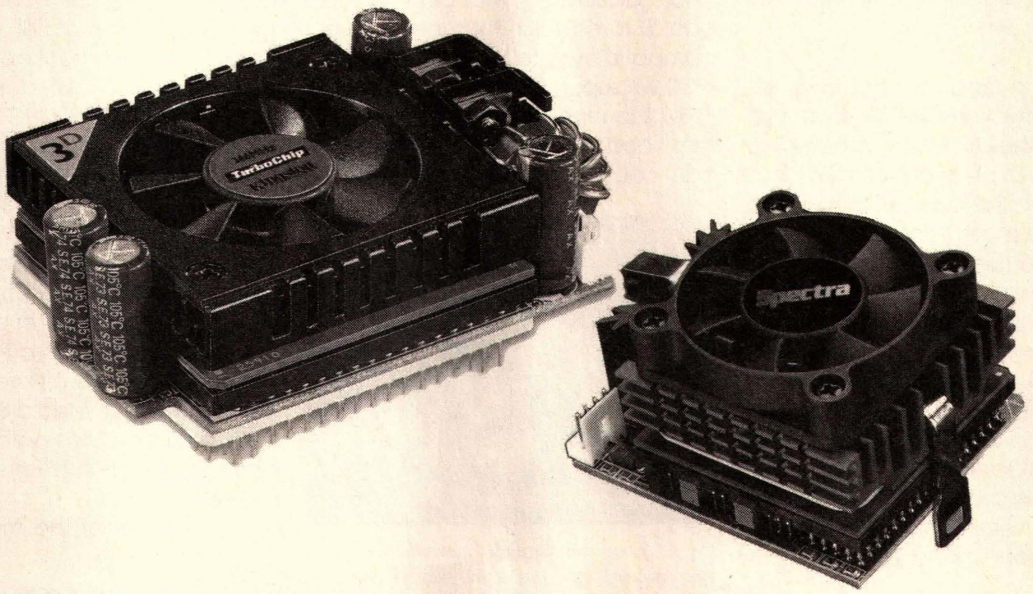
Micron Electronics decided to offer an innovative solution without the wait. Sidestepping the entire 820 core logic structure altogether, the vendor's Pentium IIIB motherboard designs are based around the Apollo Pro 133A core logic set from Via Technologies. Via Technologies, based in Taiwan, is a popular alternative to Intel among motherboard manufacturers and has recently bought the Cyrix name and CPU designs from National Semiconductor. The Apollo Pro 133A does not support RAMBUS memory, though it does provide a 133-MHz front-side bus and support the

(Continued on page 55)

Upgrading a CPU

Squeeze a little extra life out of that old computer sitting on your desk. We look at two affordable, easy upgrades that will have your system buzzing through new applications with ease.

TED NEEDLEMAN



One of the problems with being the first "kid" on the block with the newest equipment is that you're also one of the first on the block with the oldest, as well. That's the position in which many eager beavers who rushed out to buy new Pentium-based PCs when they first became available now find themselves.

Granted, there comes a moment when you just have to bite the bullet and admit that it's time to put that old machine out to pasture or pass it along to someone who will regard it as a good introduction to the joys of computing.

Before you do that, however, consider an upgrade that might give you another year or two (or more) of use from your trusty old system. Assuming that you've managed to keep pace over the years with the great improvements in video cards and hard disks and you are still satisfied with the performance that these peripherals offer, upgrading the CPU in your system may provide new operating life—at a reasonable cost. And the process is both quick and easy.

We Can Make Him Faster ... Stronger.... Before you rush out to upgrade the CPU in your system, however, consider the system as a whole. Depending upon what kind of applications you typically run and what the other components inside your PC are, a CPU upgrade can breathe new life into your system or just make it wheeze along a bit more rapidly. That's because, while processor vendors may advertise faster-faster-faster processors, it's not just CPU speed (and type) that determines how well an application will run. "Performance" is a catchall term that means different things when talking about different parts of a PC. CPU speed is one factor that influences performance; so is the system bus speed. Video-subsystem performance is important in some applications, especially in gaming; and hard-disk performance plays a great role in other applications, such as database management.

So step one of any upgrade is to first look at the applications that you run; try to determine, as best you can, what system resources they make most use of. This isn't always easy to do, but some applications are kind of intuitive. Games use both CPU and video engine resources. Any application where you can hear the hard disk flailing away is obviously disk intensive. Many graphics applications, including CAD, modeling, and video editing, are both compute-intensive (use a lot of CPU cycles) and graphic-engine intensive. And if you are considering adding a DVD drive to an older system, but don't have a hardware MPEG-2 decoder card, you may have a problem with having enough power for software decoding even if you perform a CPU upgrade.

Where a CPU upgrade does provide visible and noticeable improve-

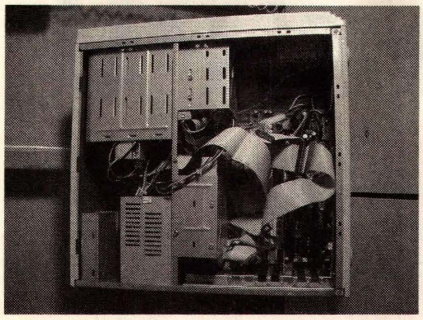


Fig. 1. Where's the CPU? Locating it may take some patience—underneath all of these cables and wires is the socket you need.

ment is in running many games, as well as everyday applications such as spreadsheets. Word processing often runs a bit more rapidly, but applications like desktop publishing benefit the most from a faster and more powerful CPU in your system.

Keep in mind, however, that if your PC has a molasses-slow hard drive and an ancient local bus video card, adding a faster CPU will speed things up a bit, but not as much as you might expect. The best candidate for a CPU heart transplant is a PC that's been well cared for, with a moderately fast hard drive and good video.

What's Available. We looked at CPU upgrades from two vendors: Evergreen Technologies and Kingston Technology. These two vendors make a number of CPU upgrade products, but we asked for only one from each of them.

Evergreen provided us with its *Spectra400* ($229, MSRP), but it makes both slower (and less expensive) Pentium upgrade modules, as well as an interesting PCI card upgrade module and a module that upgrades older Pentium II systems to a fast 400-MHz Celeron processor-based PC. We did not bother to review the slower Spectra products. If you are going to upgrade, it makes sense to upgrade to the most powerful CPU your system will accommodate, especially since the cost of the less powerful upgrade is not all that much lower. The converse applies to the PCI card upgrade, which essentially replaces much of the motherboard functionality onto the upgrade card. With a cost approaching $400, in most cases it makes better economic sense to replace your older PC with an inexpensive Celeron-based PC—which are available for $500 or less.

Kingston Technology supplied us with its *TurboChip 366* chip ($209, street). The 366-MHz version we tested was at the time of this writing the vendor's top-of-the-line offering (and an affordable one at that).

With both these vendors, it's a good idea to call or e-mail them with the model number of your computer (more accurately, that of its motherboard) to establish that there are no compatibility problems. Not every BIOS will support far more advanced CPUs than the one found in your system, and this lack of compatibility can cause problems if you plunge

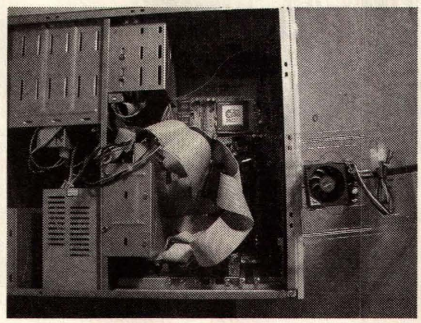


Fig. 2. If you can, carefully move the cables in your system's case out of the way to give you room to work.

ahead without checking. The folks at Evergreen Technologies have a short test program they can e-mail you. If you run it and send the results back to them, they can tell you if the upgrade will work in your system.

Kingston handles these upgrade issues by posting a list of compatible motherboards on its Web site. If you can't find the documentation that came with your PC, you can often find out the motherboard brand and model by running a shareware program called *SANDRA* (short for System Analyzer Diagnostic and Reporting Assistant), available on many shareware sites or from the Web site of its creator: 3B Software. After downloading and installing the *SANDRA* software, run it and choose the icon for Main Board Information. In many cases, *SANDRA* will list the motherboard vendor and model number.

Plug It In, Plug It In. Conceptually, both the upgrades we performed were very similar. The module pictured in the step-by-step figures that accompany this article is the Kingston TurboChip 366. The Evergreen Spectra400 is similar, but fastens to the CPU socket slightly differently. This difference is covered in detail later on.

Both CPU upgrades also use the same CPU—an AMD K6-2 With 3DNow! Technology. This CPU is similar in design to Intel's Pentium II, but offers a bit lower level of performance. Unlike the Pentium II CPU, the AMD offering will fit in many Socket 5 and Socket 7 motherboards. This socket design uses a form factor called PGA (pin grid array) where the CPU is a chip about an inch-and-a-half square, with lots of pins on the bottom side. Pentium II and Pentium III CPUs use a cartridge design and a completely different motherboard socket (Slot 1). On the other hand, Intel's Celeron processor is a PGA device (though it uses a different motherboard socket, called a Socket 370), but sometimes comes with an adapter card to plug into a Pentium II-type socket.

Assuming that the motherboard

VENDOR INFORMATION

3B Software
PO Box 4631
Hayward, CA 94540
www.3bsoftware.com
CIRCLE 180 ON FREE INFORMATION CARD

Evergreen Technologies
808 NW Buchanan Ave.
Corvallis, OR 97330
541-757-0934
www.evertech.com
CIRCLE 181 ON FREE INFORMATION CARD

Kingston Technology Company
17600 Newhope St.
Fountain Valley, CA 92708
888-435-5170
www.kingston.com
CIRCLE 182 ON FREE INFORMATION CARD

PassMark Software
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Miranda, 2228
Sydney, Australia
61-2-9326-5476
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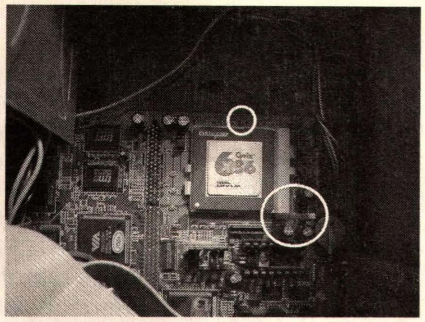


Fig. 3. The CPU that you will be replacing resides in a ZIF socket. To remove the CPU, you must first unlock the socket with the lever (large circle). Also shown in this picture are some of the jumpers you may have to reset (small circle).

in your PC has a compatible BIOS, performing the actual upgrade is pretty easy. The first thing is to unplug the power cord and remove the case or side panel of your PC so that you can get to the CPU socket on your motherboard (see Fig. 1).

Once you've got the system open, you need to find the CPU socket. On our upgrade, we were able to expose the CPU socket, as well as the motherboard jumpers that one upgrade required we reset, by simply moving the cables and wires gently out of the way (Fig. 2). On some PCs, you may need to carefully remove interfering cables to gain better access to the components you need. **If you do this, make some notes as to which cables go where and the orientation of the red stripe on the cable, so you can plug the cables back in correctly!**

The next step is to remove the old CPU. Almost all modern CPUs are mounted in a ZIF, or zero insertion force, socket. This socket has a small lever (Fig. 3), which needs to be gently moved to the vertical position to unlock it to remove the old CPU. Before you touch anything inside the case, especially the CPU, make sure you ground yourself to drain off any accumulated static charge. Then, carefully pull the old CPU straight up and out (Fig. 4).

With the old CPU removed, the CPU upgrade can be carefully installed. All Socket 5 and Socket 7 ZIF sockets have one corner with no pins (see Fig. 5). The upgrade module has a similar configuration to help you orient it correctly. Line up the module with the socket, and carefully drop the chip into the ZIF socket. **Do not force it!** If the pins on the module are correctly lined up with the socket, the module will just drop into place. If it doesn't, either you have not lined it up correctly, or you may have bent some of the pins and will need to straighten them before installing the upgrade module.

Both the upgrade modules we tested need to be connected to the PC's power to provide power for the fan mounted to the CPU heatsink. This is done in one of two ways. The first method is to attach the module's connector to a free power supply connector. The second way is to remove the power supply connector from a hard disk drive or CD-ROM drive, attach the module's connector to this power cable, and plug in the power pass-through on the module's power connector to the drive where you removed the power connector (see Fig. 6).

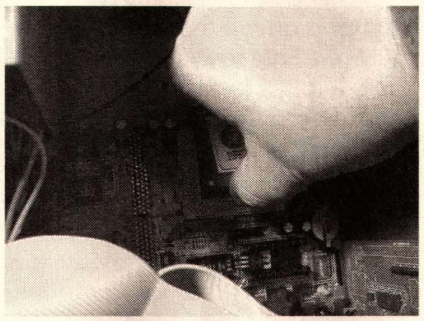


Fig. 4. After you're sure you are electrically grounded, carefully lift the old CPU out of the socket.

The last step varies. With the Evergreen Technologies' module, you will probably have to reset several motherboard jumpers. Depending on your system, you may have to reset the CPU voltage supply as well as the system multiplier. To do this, you will need the original documentation that came with your PC or will need to use a diagnostic, such as the *SANDRA* utility that was mentioned earlier, to determine the vendor and model number of your motherboard. Then you can go to the vendor's Web site and try to find the correct jumper settings for it.

Now for a closer look at the upgrade CPUs themselves.

Evergreen Technologies Spectra400. Of the two upgrade modules we looked at, the Spectra400 is the faster, using a 400-MHz version of AMD's K6-2 With 3DNow! processor. The installation procedure for the Spectra400 is also slightly more involved than installing the Kingston upgrade. This is due to three factors: the Spectra400 is designed to replace the CPUs in PCs as slow as 75 MHz; Evergreen provides a BIOS upgrade for many systems; and the module itself may be a bit more difficult to install in some systems.

As mentioned earlier, before you purchase the Spectra400, it's best to check whether or not your motherboard will support the upgrade. Our test system was a several-year-old PC from Tiger Direct. It uses an FIC motherboard and originally had a Cyrix 6x86 CPU running at 100 MHz. The Evergreen utility we discussed earlier indicated that the Spectra400 would work with this motherboard.

Before actually installing the Spectra400 upgrade module, you need to first run another utility that's included with the chip. This software application determines whether your BIOS needs to be upgraded to support the 400-MHz AMD K6-2 With 3DNow! CPU. Our test system did, and the software automatically flashed the BIOS with an upgrade. The next step was to install the module. We found this a bit more difficult than the same task with the Kingston upgrade, as the Spectra400 has a clip that must be fitted over the ZIF socket to hold the heatsink and fan in place after the module has been locked into the ZIF socket.

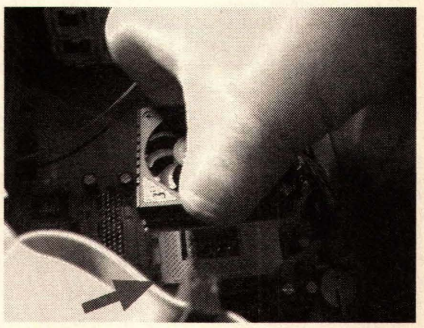


Fig. 5. Making sure that you have the pins aligned correctly (the socket has one corner with fewer pins—indicated by the arrow), carefully place the upgrade module into the socket and then lock the lever.

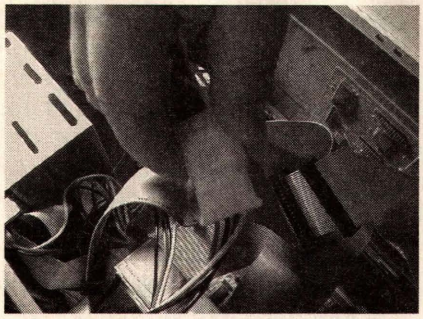


Fig. 6. Hook up the power connectors (which power the fan on the heatsink), and you're ready to start testing. You may also have to reset some of the jumpers on the motherboard.

On our test system, a set of motherboard jumpers located very close to the ZIF socket blocked easy placement of the clip. We finally solved this problem by gently bending the jumper pins to a 45-degree angle with a pair of needle-nosed pliers. These pins are very fragile, howeve;, and we were a bit nervous about breaking them completely off of the motherboard, which fortunately did not happen.

The Spectra400 installation process also required us to set two different motherboard jumpers—one to reset the CPU supply voltage, the second to reset the CPU clock speed multiplier from 60 MHz (the setting used with the Cyrix CPU) to 66 MHz (the setting needed to get the full speed out of the Spectra-400). Finding the correct setting for the CPU multiplier took some trial and error, as the motherboard documentation was apparently in error.

Once we hit the correct settings, the difference in performance and the time it took to boot the PC were immediately apparent.

Kingston Technology TurboChip 366. Like the Spectra400, Kingston Technology's TurboChip 366 uses an AMD K6-2 With 3DNow! processor mounted on a special adapter card and incorporating a heatsink and fan assembly. As evident from its name, the TurboChip 366 uses the 366-MHz version of the AMD CPU, slightly slower than the 400-MHz processor Evergreen's upgrade offers.

On the other hand, Kingston's TurboChip 366 is even easier to install. Meant to upgrade Socket 5 or Socket 7 ZIF-based systems that initially held a Pentium, AMD K5 or K6, or Cyrix 6x86, the TurboChip worked in our test system (which originally had a 100-MHz processor installed), but only after we had already reset the motherboard jumpers for the Evergreen upgrade. In most installations, however, there will be no need to touch any of the jumpers on the motherboard.

Unlike Evergreen's Spectra upgrade, the TurboChip 366 requires a BIOS that will support the faster processor—it does not come with a flash upgrade utility. Be sure to check that list on Kingston's Web site before proceeding with the upgrade.

Assuming that your system is listed, upgrading is simply a matter of unplugging the old CPU and plugging in the upgrade. Again, you will have to connect the power adapter between the power cord and one of the disk drives (or a free connector, if your PC has one) to power the fan on the heatsink. The small adapter card that the new AMD CPU is mounted on, however, contains circuitry to automatically provide the correct voltage to the CPU and to adjust the TurboChip 366 to the system bus speed. The TurboChip 366 will operate at a system bus speed of up to 95 MHz, if your motherboard can be adjusted to such a setting. Our test system's couldn't; it was fixed at 66 MHz, which did have some noticeable impact on our benchmark test results.

The Results are In.... Is a CPU upgrade worthwhile? In many cases, where you need a bit more performance and don't want to spring for a lot of money, the answer is a resounding yes! Table 1 shows the results of the two CPU upgrades we performed. To quantify the upgraded performance, we measured performance using two different benchmark tests. The more comprehensive of the two, *PerformanceTest* from PassMark Software, performs 28 different tests (including tests of MMX functionality, hard disk performance, and RAM memory performance) to come up with a single "PassMark" score. Results for each of the individual tests are also available from running the *PerformanceTest* utility, though they are not presented here. Also used as a basis of comparison are the CPU and Multimedia CPU Benchmarks contained in the *SANDRA* utility. The results of these tests measure integer and floating point performance, both of which are processor oriented.

In the results presented in Table 1, you'll notice that a PassMark score is not presented for the base configuration. That's because the *PerformanceTest* utility was not able to accurately compute a "PassMark" score. That's not the fault of the software, but rather because the system we upgraded originally contained a Cyrix 6x86 CPU running at 100 MHz. The Cyrix 6x86 was introduced before Intel added the MMX instruction set into the Pentium. As such, it could not run the complete PassMark test suite, which does use MMX instructions in some of the tests it performs. Both the upgrades we performed

(Continued on page 54)

TABLE 1—BENCHMARK RESULTS

	PassMark	SANDRA CPU Test	SANDRA Multimedia CPU Test
Cyrix P120 (original CPU)	Could not run	CPU: 319 MIPS FPU: 103 MFLOPS	Integer ALU: 108 iterations/sec (it/s) Floating Point: 45 it/s
Evergreen Upgrade	35.5	CPU: 529 MIPS FPU: 465 MFLOPS	Integer MMX:1051 it/s Floating Point: 788 it/s
Kingston Upgrade	33.3	CPU: 599 MIPS FPU: 432 MFLOPS	Integer MMX: 964 it/s Floating Point: 723 it/s

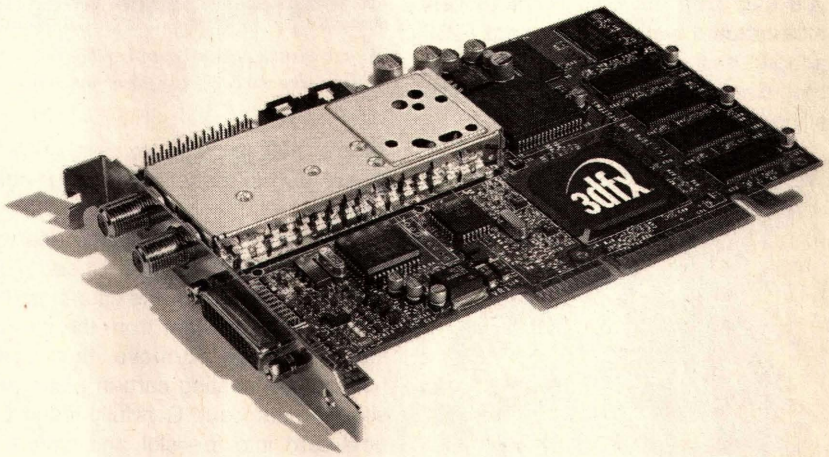
SELINA KYLE

A Combo Video Upgrade—MPEG-2, TV, and Killer Graphics

This month we'll be looking at a way to add some real pizzazz to your computer's video system—to the internal circuitry that sends images to your monitor. What we're about to undertake is an upgrade that's easy to perform and even easier to enjoy.

You might have noticed the word "combo" in this column's title. This is because our add-on is much more than just a standard card. Computer video hardware can be thought of as performing two types of functions: generating 2D and 3D images from computer data and working with I/O from non-computer or standard video. The card we'll be looking at this month handles both of these types of tasks.

Interested? If you aren't yet, you will be when you read the specifics of 3dfx's *Voodoo3 3500 TV AGP* card ($249, street price). It impressed us so much when we covered it in *PC Gizmo* last month that we just had to take a closer, hands-on look.



The Voodoo3 3500TV AGP board provides stellar gaming and high-quality manipulation of composite-video and S-Video sources.

YOU NAME IT, IT MAY DO IT

For starters, if you're going to upgrade your machine's video adapter, you want the new card to be better at everyday 2D tasks. Here the Voodoo3 keeps up with the best of the competition. With 16MB of SDRAM memory and an AGP 2X interface, the card can handle resolutions as high as 2046 × 1536, and it can do so with eye-strain-free refresh rates. The 350-MHz RAMDAC ensures high-quality output all around.

In the world of 3D, however, the Voodoo3 excels. Running at a core clock speed of 183 MHz, the card can produce up to 8 million triangles a second, which translates into a level of gaming reality that you have to see to believe. Forget about jagged or rough-looking graphics from modern games. If the 3dfx chipset is supported by it, a new game will look almost cinematic at times.

But, as we hinted, this is much more than just a business/gaming card. The 3500 TV allows you to do what only used to be possible with overpriced capture cards, not to mention what wasn't possible at all on a home PC. The former is, of course, full-motion video capture; and, as we'll get to a little later on, the 3500 lets you perform this task with a new level of ease. The task that used to be impossible at home was the encoding of MPEG-2 video on the fly. That's right; the video you capture can be stored in the same compression format as the content found on DVDs.

Because of the card's MPEG-2 capabilities, the 3500 TV can also play back DVDs. If you haven't yet added DVD to your PC, this card will make such an upgrade even cheaper. Now, you can just buy a standalone drive for well under $100 (we've seen them as cheap as $50) and consider your movie-watching setup complete.

Also in the realm of entertainment, the 3500's TV/FM tuner lets you make the most of both of these signal sources. Enjoy the evening TV news or a call-in radio show while catching up on work. Record content from either

TV or radio in perfect digital clarity and then edit at will. However you use it, the 3500 TV turns your computer into a state-of-the-art entertainment center.

THE SWAP

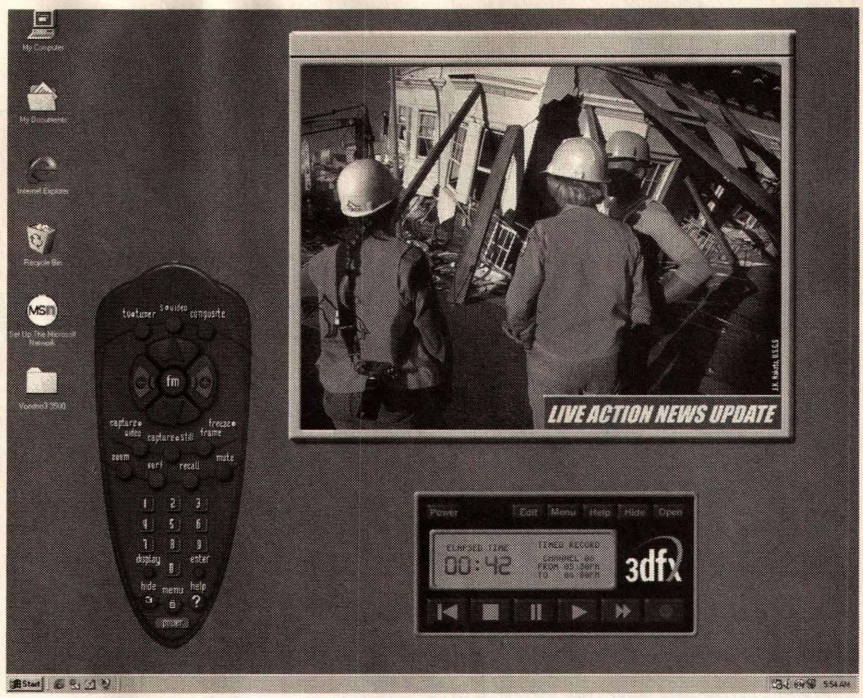
As great as the Voodoo3 3500 TV AGP may sound, do a quick system check before running out and buying one. We have to point out that the card will only work in a system that supports 2X AGP. If your machine has an older bus, you'll have to check out other PCI offerings from 3dfx or other companies or wait for the 3500 TV PCI version (which should be available by the time you read this).

Have AGP? Great ... or maybe not. If your current AGP video adapter is a plug-in card resting in an AGP slot, you're set. If your current adapter is built into the motherboard, however, you might be out of luck. Not every motherboard with an onboard AGP adapter has an expansion slot or AGP port. Check to make sure there's actually a place to plug in the 3500.

Except for cable TV and FM antenna, connections to the 3500 TV are made via the innovative I/O Pod shown here. Forget about reaching behind your PC to work with video sources.

Finally, you might want to consider one last system requirement: a peppy processor. The card will work on a 266-MHz machine or better, but for best MPEG-2 capture results, you'll need a 500-MHz PIII. If recording DVD quality video is what you plan on doing, make sure your PC's up to speed, literally.

We'll assume that you're replacing an existing AGP card. Doing so is not a Herculean task. Step one is to run SETUP.EXE off the CD that came with the card. This lets the *Quick Install* software check your computer's configuration. It will also give you some simple install steps to follow (print these out in case something goes awry).



With its virtual remote control and onscreen VCR-like controls, the software included with the 3500 makes using the card easy for almost anyone.

Shut down your computer, leaving the CD in the drive (you'll need it on the next boot). Open the case and disconnect your monitor from the current video adapter. Remove the screw holding the existing card in place and slide the card out. Carefully insert the new card into the slot and secure it with the screw.

Now you'll have to make some connections. Attach the standard stereo audio cable from the Audio Out on the 3500 to the Line or Aux stereo input of your sound card. Next, pick up the Custom I/O Pod. One end of the attached cable will have a connector that you attach to the 3500—the other end will connect to your monitor (more on the Pod in a moment).

Restart your computer, let Windows access the CD to complete the installation, and you're all set to start using your new Voodoo3 3500 TV card.

VENDOR INFORMATION

3dfx Interactive, Inc.
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San Jose, CA 95134
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CIRCLE 110 ON FREE INFORMATION CARD

EASY-REACH I/O

Whatever applications you may have in mind for the 3500, they'll be easier to accomplish without having to constantly reach behind your PC to make video and audio connections. The I/O Pod has made such inconveniences a thing of the past.

The little oval wonder has eight connectors, four on either side. These are logically placed, with all inputs (Left Audio, Right Audio, Composite Video, and S-Video) on one side, and the corresponding four outputs on the other. You can plug in and swap camcorders, DVD players, you name it, all on the magic Pod that can rest right on the desk in front of you.

The only connectors found on the card itself are the Cable TV and FM Antenna inputs. Of course, you only make these connections once, barring moving the PC to another location.

APPS ENCLOSED

We really liked the software bundle that comes with the 3500 TV. Regardless of which feature of the card you try to access with the 3dfx applications, you'll find the software to be intuitive and more than a little familiar. In other words, while you may be

(Continued on page 48)

COMPUTER BITS

TED NEEDLEMAN

PC-Generated Ink Stamps

If you follow this column, you already know that I try to illustrate the use of computers to actually solve a problem or accomplish a task. This month, the task I wanted to accomplish was a bit unusual. I'm sure, however, that if you follow my narrative you'll come up with some uses for the technologies discussed herein.

One of my interests is the Martial Arts. Recently, I was invited to sit on a panel testing a candidate for his Black Belt. Depending on the style being studied and the particular school, your instructor may just hand you your belt when he or she feels that you're ready for it, or you may be asked to take a test. In the two styles I train in, to receive a promotion to or within the Black Belt ranks, you generally are asked to test in front of a panel of other Black Belts. It's an honor to be asked to serve on such a panel and to sign the candidate's Certificate of Rank if he or she makes the cut. The invitation to participate in the panel ended with an admonition to bring my "honko."

To be honest, I'm only a so-so martial artist. But I'm an even poorer linguist. When I asked for a translation, I learned that honko is a Japanese word for a small wooden stamp that contains an individual's "chop." In Asian countries, this chop is the equivalent of a signature, and there are plenty of artisans who will make up your honko, carving it into a small piece of wood. You use the honko by pressing it into an inked pad and stamping the object you want to mark. In many places in the Orient, these honkos can be obtained for less than $10. Here in the US, however, they tend to be much more expensive, sometimes as much as $100 or more. I've never really felt the need for one (nor had the 100 bucks to blow on having one made), but having been asked to bring mine to the promotion test got me thinking.

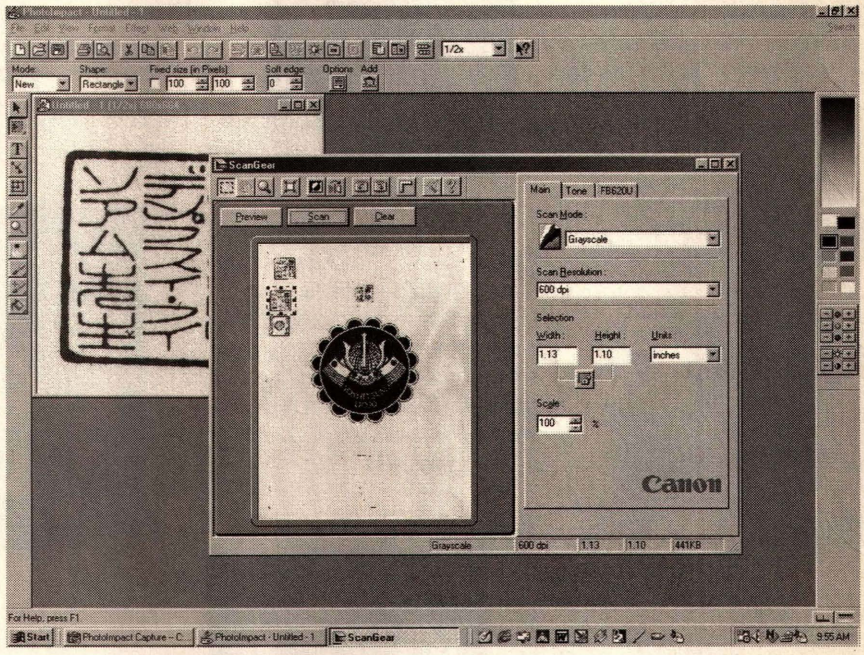

Fig. 1. The first step in creating a stamp is to scan the artwork—in this case a Kanji translation of a martial artist's name and style.

TECHIE HONKO

Fortunately, I had a product sitting here to review that could easily solve most of the problem. The *SC-900 Stamp Creator*, from office equipment giant Brother International, does only one thing. It lets you make self-inking stamps. If you've ever seen the "X-Stamp" brand of stamps in an office-supply store or catalog, you know exactly what I'm talking about. This type of stamp has an inked pad contained in it; and when you press the stamper against a piece of paper, it leaves an inked impression without the need for a separate inkpad. A cover keeps you from leaving ink all over the place when the stamp isn't being used.

The SC-900 StampCreator, which has a list price of $499, but a street price closer to $299, uses stamp blanks that contain a piece of thin

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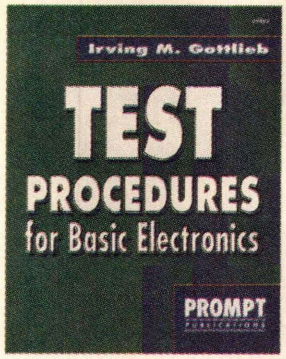

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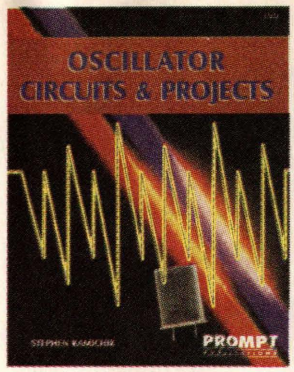

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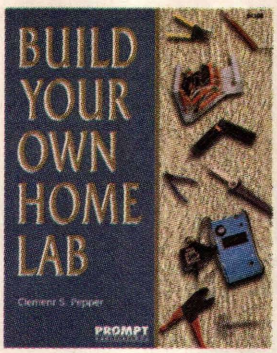

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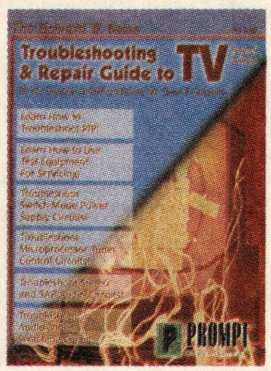

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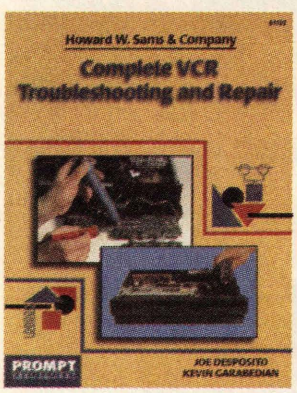

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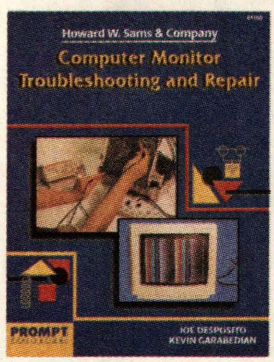

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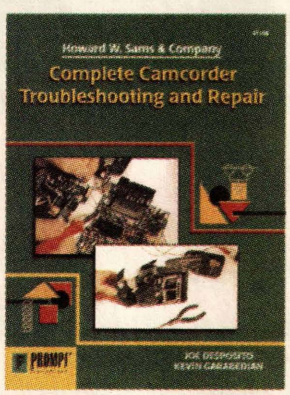

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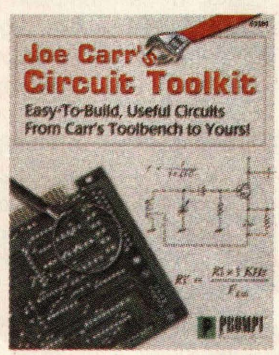

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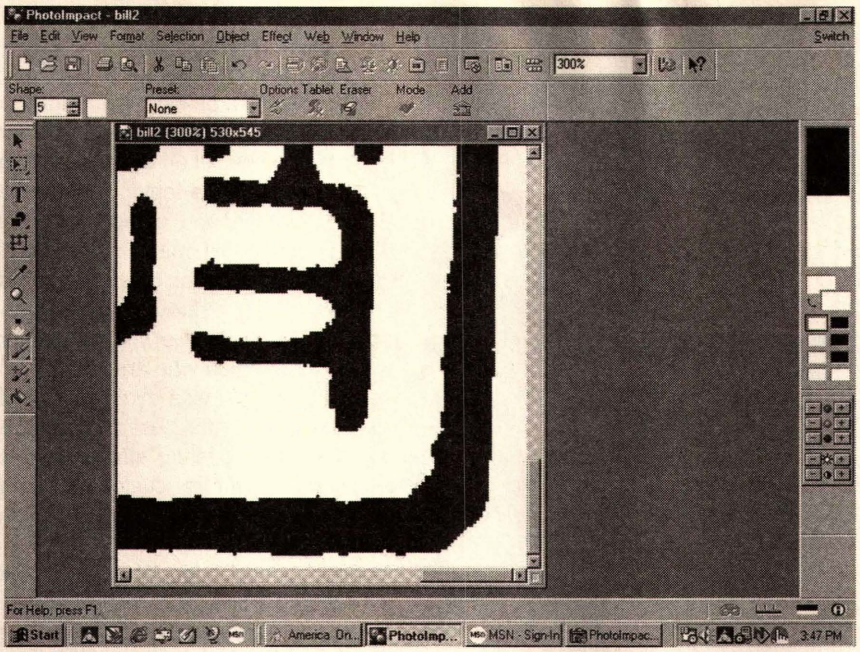

Fig. 2. I used PhotoImpact 5.0 *to clean up the scan.*

material covering the inked pad. During the creation process, a thermal printhead actually burns small holes in this material. When you press the stamper against a piece of paper, ink is forced through the holes, leaving an inked impression. With its resolution of 360 dpi, the StampCreator can burn some fairly involved graphics ... a feature I was counting on putting to good use. You can also use the provided *Stamp Editor* software to burn your own message onto a stamp; or you can choose from among dozens of templates to create custom return-address, check-endorsement, and standard office-use stamps. The SC-900 connects to a PC through a serial port, and the cable also has a connector for a Macintosh mini-DIN serial connector.

Strangely enough, the most difficult aspect of this month's project has turned out to be the language part. While a honko can contain pretty much anything you want it to, most martial artists' honkos have their name and school or style in Kanji, the Japanese pictograph language. Kanji is written vertically and from right to left, so a typical honko has the person's last name, first name, and style or school in three vertical rows. Fortunately, one of my fellow practitioners knows someone who can do the translation, so while I'm waiting, I worked out the rest of the process.

I started with my instructor's honko, figuring that once I receive the Kanji translation I am waiting for, I'll simply scan it, reduce it, and burn it into a stamp blank. To test how well this would work, I had my instructor make a number of impressions of his traditional wooden honko. I then scanned it in grayscale mode at 300 dpi. I used grayscale mode, even though I would eventually need a binary (black and white) image, because it contains more image data. I did find that I had to play with the threshold control in the scanner driver to obtain the best image. The threshold control works a bit like a volume control, adjusting the scanner's sensitivity. Most of the time, the automatic settings work well, but I was scanning a red-orange image into grayscale, so I wanted the best possible scan starting out (see Fig. 1).

To convert the image from grayscale to line-art and to tweak it a bit, I installed the latest version of *PhotoImpact 5.0*, from Ulead Software. PhotoImpact is an image-editing package, similar to *Photoshop*, but I find it a lot easier to use most of the time. It contains a menu selection that lets you switch between image formats, which I used to convert the grayscale into 1-bit line art. Then, I used the paintbrush tool to edit out some of the artifacts that the scanning process introduced (see Fig. 2).

When I was satisfied with the way the image looked, I saved the file in .BMP format and fired up the Brother *Stamp Editor*. The Stamp Editor screen is very easy to use. First, you need to set the size of the stamp blank. Blanks for the SC-900 come in four sizes, ranging from #10 ($1\frac{1}{4} \times \frac{3}{8}$ inch) to #40 ($2\frac{3}{4} \times 1\frac{1}{8}$ inch), and in three colors, black, blue, and red. I wanted the finished image to be about an inch square, so I used a #40 blank.

The image is easily imported, using the Image icon on the bottom of the screen. Once I placed the image in the

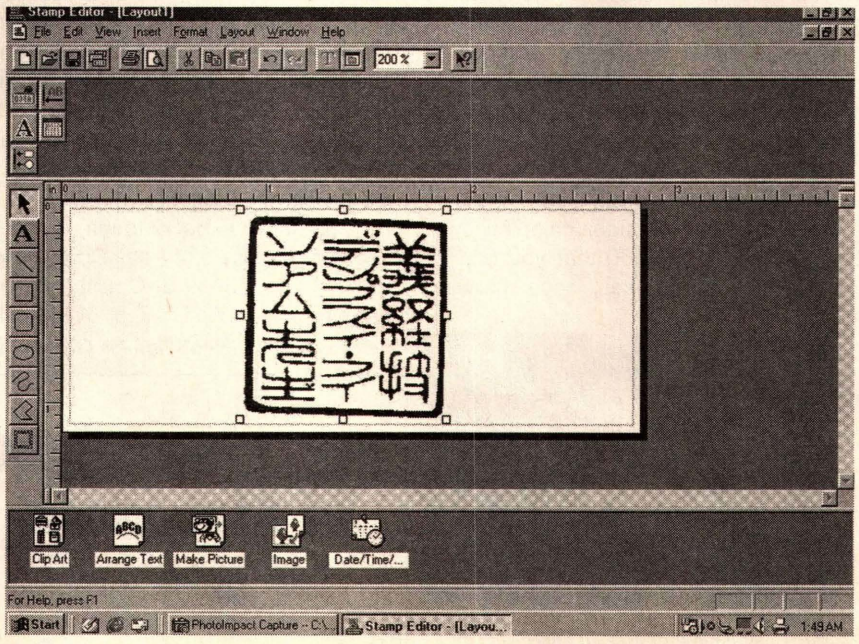

Fig. 3. Brother's Stamp Editor *software makes it easy to design your stamp.*

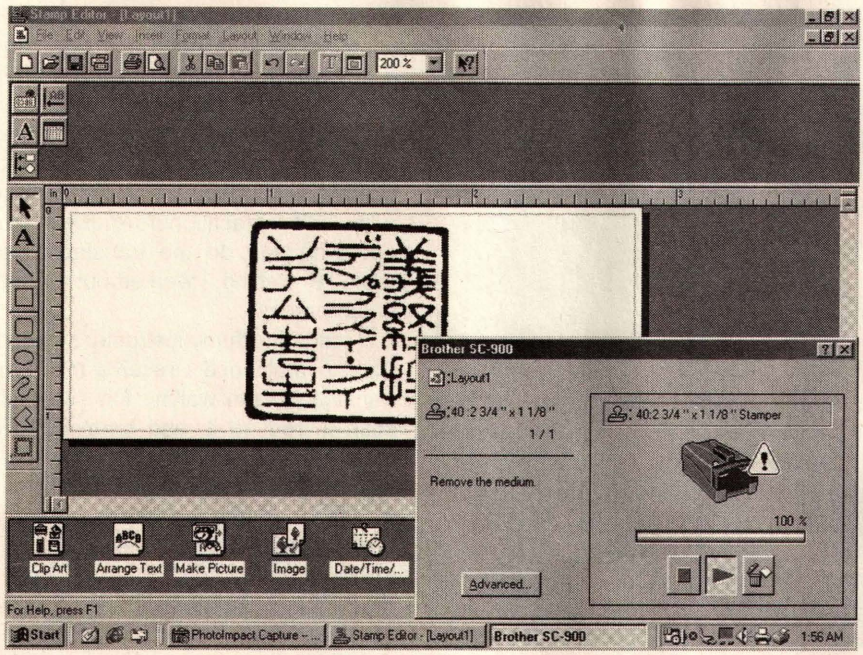

Fig. 4. The last step is to "burn" the stamp blank.

representation of the stamp that fills the center of the screen, I resized the image and placed it in the center of the "stamp" (see Fig. 3). Actually creating the stamp requires that you burn a trial image, using special paper blanks and a holder that's supplied with the SC-900. When you are satisfied with the trial image, you assemble the stamp blank (the stamp portion is sealed to keep the ink fresh), insert it in the SC-900, and hit the "print" icon. About a minute later, the stamp is ready to use (see Fig. 4).

My trial run with my instructor's honko image worked fine, and I'm just waiting for the completed translation of my name to create my own honko. I've even received a half-dozen requests for honkos from fellow practitioners!

YOU DON'T LOOK JAPANESE

As I mentioned at the beginning of this column, I like to illustrate the use of a particular type of hardware and/or software by solving a real-world kind of problem. Of course, the world I live in is colored by my own interests and situations, and therefore probably somewhat different than one you live in. (Actually, my wife often claims that the world I live in is different from the one *everyone* else inhabits!) So the challenges you are looking to solve may be a bit different than mine.

That's fine. If you don't need your own honko, there are plenty of other tasks you can put the Stamp Creator SC-900 to use on. The most obvious one is in an office, where there's a need to continually generate both standard and custom self-inking stamps. You may be able to buy a self-inked stamp with a message such as "FRAGILE" for less than the cost of a Stamp Creator blank. But when you figure in postage and handling on the order, and the fact that you'll have to wait a week or two (or more) to receive your stamp, the economics change somewhat. Of course, you have to have a need for a fair number of stamps, custom or otherwise, to justify the $300 street price of the Stamp Creator SC-900. If you share office space with a number of other businesses or are friendly with others in your building, consider chipping in to purchase an SC-900 that you can all use. Five businesses, each throwing $60 into the kitty, makes the purchase of a $300 office system a lot more palatable and a lot easier to justify.

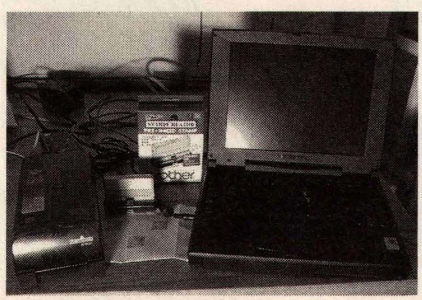

Fig. 5. Here's everything that's needed to create custom self-inking stamps.

Another interesting use might be craft fairs. Lots of malls often have various craft booths set up at different times of the year. With a laptop, an SC-900 Stamp Creator, and a nice supply of blanks, you could make some significant extra cash over a few weekends churning out custom deposit and address stamps while your customers wait. Those of you who are already in a service-type business might be able to alleviate some of the cost of purchasing an SC-900 by offering stamps to your existing and future customers. Who knows, you might even turn it into a new profit center.

That's all for now. You can contact me with questions and comments directly by e-mail at *tneedleman@aol.com*. P

PEAK COMPUTING

(continued from page 44)

clicking on buttons on the screen, you'll feel almost as if you're punching in a channel on a remote control or hitting Play or Record on a VCR. It's really that simple.

Everything you'd expect from a consumer video device is here, including programmable recording, channel blocking, and the like. In many ways, the 3500 TV is a decent replacement for those pricey new Digital Video Recorders like the TiVo or ReplayTV (though these devices do have useful monthly programming services and record/playback multitasking unavailable on a PC).

So get cracking. The fun you can have with digital video is something to experience firsthand.

If you'd like to get in touch, feel free to contact me care of *Peak Computing*, **Poptronics**, 500 Bi-County Blvd., Farmingdale, NY 11735, or directly via e-mail at *selinakyle@techie.com*. P

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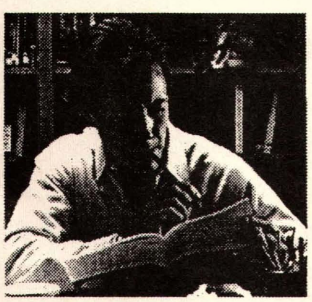

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NET WATCH

BROWSER TIMESAVERS

A great many of us take its seeming simplicity for granted. We type URLs into it, point and click from virtual here to virtual there in its window, and use it to browse to our hearts' content. All the while we assume we've got that free browser program (in my case, Microsoft's Internet Explorer 5 or IE5) all figured out and tamed to provide the best Net experience possible.

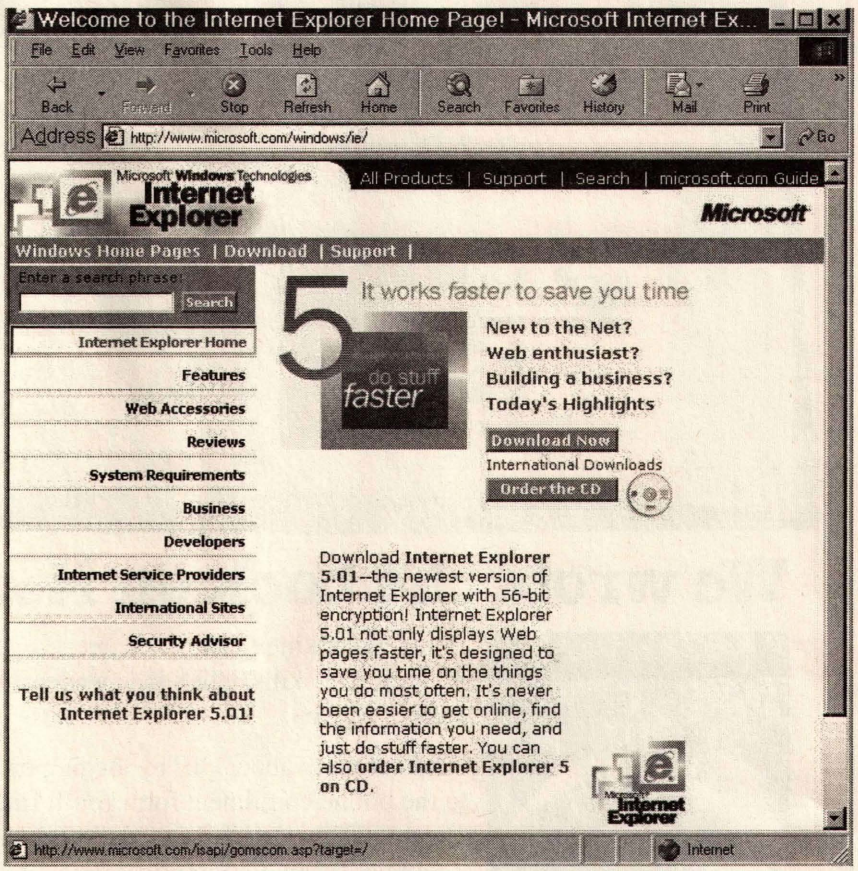
But do we really? Could it be that the pane through which we view the Web is causing us unnecessary pain?

We're creatures of habit, most of us; and it's often the case that our habits are less than efficient. Months or years filled with needlessly wasted moments may pass until we learn that we've been doing something the hard way all along.

In the world of computing, this "hard way" could be something simple like the multi-step fashion in which many people close Windows applications. You don't know how many PC users we've seen click on the File menu, scroll down to Exit, and click the latter (assuming a slip of the mouse doesn't make the drop-down menu disappear, in which case the process must be repeated). All they need do is click on the "X" in the program window's upper right corner to shut said program. One step versus three.

Of course, there are countless worse time-wasting habits than this simple example. This month, we'll look at some timesaving tips for IE5 that can help you make the most of precious moments online. And they are precious—after all, most of you reading this do not have a broadband connection coming into your home, and the Internet via modem can be frustratingly slow enough as it is.

So read on, beginners and experienced users alike. The only assumption we'll be making is that you are running IE version 5 or higher (it's actually up to 5.01 at the time of this writing). Even Netscape Navigator users may find some of these tips apply to their app as well, but focusing on two browsers is just out of the scope of a column this size. I decided to go with my personal favorite.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Internet Explorer
http://www.microsoft.com/isapi/gomscom.asp?target=/
Internet

Even on a modest PC, Microsoft's Internet Explorer 5.01 can greatly enhance the Web experience. It's a free, but lengthy download, or you can order a CD.

OFTEN-IGNORED BASICS

Long-time readers may have noticed that we stopped printing the "http://" in Web addresses some time ago. This is because IE5 and other browsers no longer require you to type this hypertext-transfer-protocol identifier. Save yourself the keystrokes. Actually, you don't need to type "www." in most cases either, but we want our published Web addresses to look instantly recognizable.

Also, when typing in the URL of a site that you've been to recently, don't bother finishing it if it's a long one. Thanks to AutoComplete, the URL you're typing may appear in a drop-

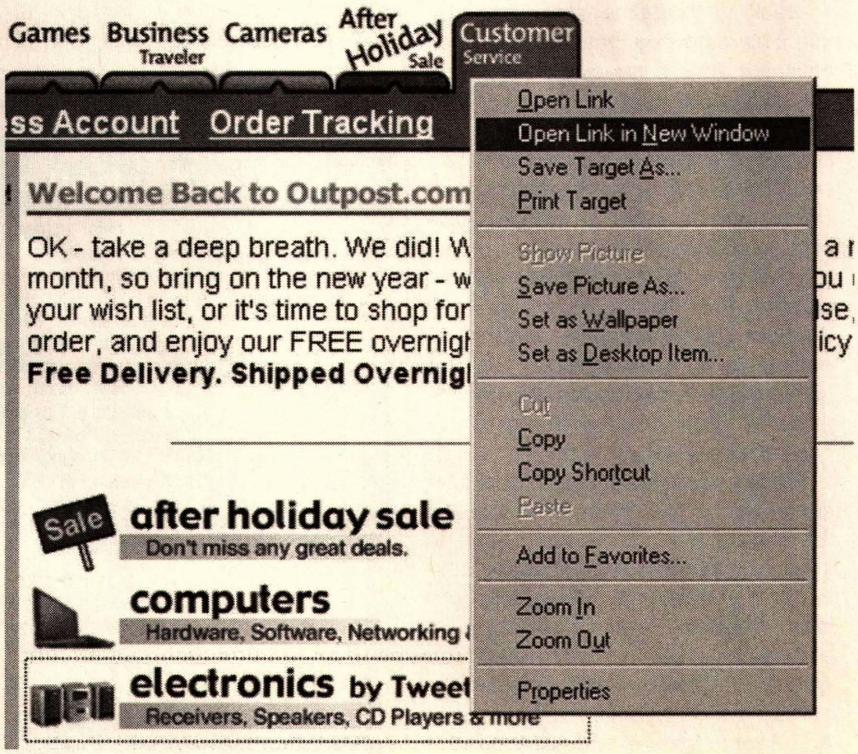
As shown here, type in the first few letters of a URL you've been to and AutoComplete will bring up the rest of the address for you.

down list, right below the address line. These "addys" are all the ones you've been to within a month that contain the same first few letters of the one you're typing now. If the URL list doesn't automatically appear, try hitting the left cursor arrow to summon it. Either way, you can scroll down the list, hit Enter, and go to the desired site. This can save you dozens of keystrokes.

Speaking of Web addresses, is there one that you find particularly useful? Most readers will be familiar with the concept of Bookmarks or Favorites—lists of addresses that your browser can maintain—and how simple it is to return to these by selecting them with a couple of clicks from the Favorites menu. Make sure you're hitting Ctrl+D whenever you find a site you like, or, better yet, select Add Favorite from the aforementioned menu (or press Ctrl+B). The latter step opens a window that lets you choose where to store this particular Favorite; and you really should be subdividing such links into folders according to topic, or before you know it you'll be looking through a list of a hundred or so to find what you want.

Few users consider the importance of their home or starting page, though. Rather than ending up at your browser's chosen opening page (like the Microsoft or Netscape ones), consider picking a new start page and making it automatically load each time. Under Tools, select Internet Options and the General tab on the dialog box will contain a line for you to enter a new "home page." A good search engine site might be an appropriate starting spot for most, while a newspaper might be more up the morning Net user's alley.

Do you have more than one Web site that you feel is important enough to start from regularly? Consider creating Desktop Shortcuts to each of these and clicking on them to launch your browser to the one you're into any particular day. To make such a visible link, visit a page, right click, and select Create Shortcut. The resulting Shortcut, which you can rename, will be placed on the Desktop.



The right-click menu of IE5 offers many timesaving features—most notable is Open Link in New Window, which lets you browse in multiple panes without the wait of constantly reloading pages.

INTELLISENSE

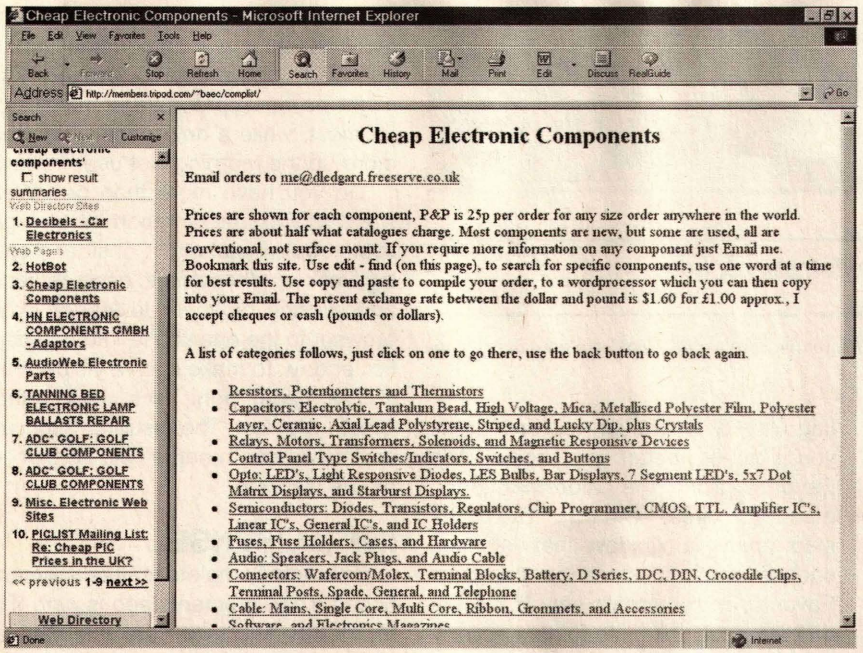
The AutoComplete feature we mentioned a few moments ago is part of a technology Microsoft calls IntelliSense. And in all its IE5 manifestations, IntelliSense accomplishes a similar task: the reduction of repetitive typing.

To use this feature, you need only be aware of dropdown menus that will appear wherever text entries are required in Web sites. For example, whenever a forms-based site asks you for your First Name, Last Name, and so on, IE5 will let you enter these the first time and will remember them for future instances. Then, you need only type the first few keys again to invoke the list of choices. I say "list," because many entries will be made differently depending on various factors. For instance, under Address lines you may type in either a work or home street designation. Just move through the short list with the cursor keys, hit Enter when you get to the correct choice, and you've saved some time.

Do be careful how you use IntelliSense, though, as it can record your usernames and passwords. Someone accessing your computer who knows the former can enter the latter, as the password will appear (as asterisks) in the dialog box after the username is entered, and the Enter key will then cause your password to be sent as if typed. Only check the onscreen "Remember Password" boxes if you're sure that no one else

HOT SITE

Microsoft Internet Explorer
www.microsoft.com/windows/ie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A list of categories follows, just click on one to go there, use the back button to go back again.
Resistors, Potentiometers and Thermistors
Capacitors: Electrolytic, Tantalum Bead, High Voltage, Mica, Metallised Polyester Film, Polyester Layer, Ceramic, Axial Lead Polystyrene, Striped, and Lucky Dip, plus Crystals
Relays, Motors, Transformers, Solenoids, and Magnetic Responsive Devices
Control Panel Type Switches/Indicators, Switches, and Buttons
Opto: LED's, Light Responsive Diodes, LES Bulbs, Bar Displays, 7 Segment LED's, 5x7 Dot Matrix Displays, and Starburst Displays.
Semiconductors: Diodes, Transistors, Regulators, Chip Programmer, CMOS, TTL, Amplifier IC's, Linear IC's, General IC's, and IC Holders
Fuses, Fuse Holders, Cases, and Hardware
Audio: Speakers, Jack Plugs, and Audio Cable
Connectors: Wafercom/Molex, Terminal Blocks, Battery, D Series, IDC, DIN, Crocodile Clips, Terminal Posts, Spade, General, and Telephone
Cable: Mains, Single Core, Multi Core, Ribbon, Grommets, and Accessories
Done
Internet

Type a plain-word search like "cheap electronic components" into the address bar and IE5 will open a search frame to the left of the screen, allowing you to browse each of the hits in the remaining frame.

will be using your machine.

COPING WITH THE WAIT

As anyone without broadband Internet access knows, clicking from site to site is not so zippy a process. Here are some ways to hit the most Web content in the shortest period of time, with the fewest moments spent staring at a blank, loading window.

For starters, you may want to free your mind from the adage about a picture's worth in words. Let's face it: more than half the graphics found on Web sites do little more than look nice (or in some cases they make a page a muddy mess, but we think beauty is what most Web designers are at least going for). If you're looking for a fact, date, phone number, or other piece of hard data, no picture could equal your goal in value. Consider turning all graphics off if you have a lot of information to dig up in a short period of time. This is easy to do. Go into the Tools menu, select Internet Options, and access the Advanced tab. In the list that appears, scroll down to the Multimedia category and click off the Show Pictures box. If you then go to a site that has a picture you think you'd like to see, right click on the little red-X-in-a-box that marks the image's place and select Show Picture from the right-click menu.

Incidentally, if you are searching for a certain keyword on a page, and don't feel like scrolling through the latter, hit CTRL+F to invoke the Find feature. Type in the query word or part of it, press Enter, and cut down on your search time.

Back to load-time reduction. You might have noticed that when you click on some links a new window opens, yet others will load the new page to replace the one you're on. The latter could get annoying, especially if you waited a long time for the first complicated page to come up and are planning on going back to it again. To open any link in a new window, right-click it instead and select Open in New Window. The resulting new window will pop up in a minimized size, allowing you to easily switch back to the original page by clicking on it in the background whenever you want.

Finally, as we all spend a lot of time searching on the Web, why not skip the step of going to a search-engine site altogether? Next time you're looking for a phrase—say "cheap electronic components" —just type it into IE5's address bar, with spaces between the words. The browser will interpret the phrase as a query, thanks to the AutoSearch feature, and will conduct a hunt for the requested info. A narrow frame will then open to the left of the browser window, listing links to the discovered matches. You can click on each and browse them in the right-side frame without ever losing sight of the total list or having to click back to find it (as is the case with most search engines).

Oh, and when you're done with that search pane, please click the little X at its top right corner to close it!

That's all for this month. If you have any questions or comments, feel free to contact me via snail-mail at *Net Watch*, **Poptronics**, 500 Bi-County Blvd., Farmingdale, NY 11735, or e-mail at *netwatch@gernsback.com*. P

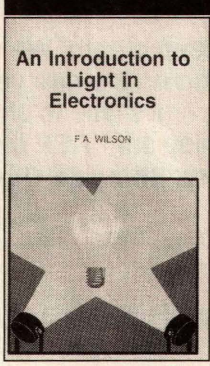
UPGRADING A CPU

(continued from page 42)

add MMX compatibility, a nice side benefit of performing the upgrade.

When you read the chart, the performance improvement from both upgrades is immediately evident. The Evergreen Spectra400, running at 400 MHz rather than the TurboChip 366's 366 MHz, provides just a touch better performance in most of the tests. Both upgrades, however, provide a significant performance improvement over the original CPU. And either, assuming that both will run in your older PC, is an excellent value and a worthwhile improvement. P

An Introduction to Light in Electronics



Taken for granted by us all perhaps, yet this book could not be read without it, light plays such an impressive role in daily life that we may be tempted to consider just how much we understand it. This book makes a good start into this fascinating and enlightening subject. It has been written with the general electronics enthusiast in mind.

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ET08

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SYSTEM DESIGN

(continued from page 38)

new PC133 RAM. Our review unit, the *Millennia Max 533B*, had 128MB of this fast memory, and the three DIMM sockets on the motherboard will hold a trio of 256MB PC133 DIMMs when they become available. An Ultra ATA/66 IDE controller is embedded on the motherboard, and the supplied hard drive was a cozy 13.6GB.

The Apollo Pro 133A chipset and the Micron Millennia Max 533's motherboard support the newest 4X AGP transfer speed. Unfortunately, the Diamond Viper 770 included with our system is only a 2X AGP card. The newer Viper 770 Ultra can be jumpered to operate at 4X AGP and is a worthwhile upgrade for avid gamers.

The rest of the Millennia Max 533B's features are fairly standard for Micron systems, though they are, by no means, run-of-the-mill. The Millennia Max 533B comes in a large, attractive mid-tower case, whose side panel is easily removed without using any tools (you need only slide a small plastic tab upwards). Inside the case, there are three fans and a swing-away plastic duct, all of which keep air moving within the case, ensuring that CPU and other component temperatures remain at a reasonable operating level.

SYSTEM SPECIFICATIONS

Model: Micron Millennia Max 533B
Price (as configured): $1655
Vendor: Micron Electronics; 625 Stratford, Meridian, ID 83642; 888-208-1937; *www.micron.com*
CPU: 533-MHz Intel Pentium IIIB
Memory: 128MB PC133 RAM, expandable to 768MB
Storage: 13.6GB Ultra ATA/66 hard disk, 1.44MB floppy disk
ROM Drive: 8X DVD
Video: 17-inch Micron 700CX monitor, Diamond Viper V770 2X AGP video with 16MB RAM
Audio: Aureal A3D wavetable, Monsoon MC-200 three-piece speakers with subwoofer
Size: 20.5 × 8 × 18 inches (HWD)
Ports: Parallel, serial, VGA, two USB
Expansion: Five open PCI slots, two open external 5.25-inch bays, one open external 3.5-inch bay, two open 5.25-inch internal drive bays
Other: Windows 98, Microsoft Office 2000 Small Business Edition

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In addition to the reasonably priced 13.6GB hard disk and a standard 1.44MB floppy, our review unit also had an 8X DVD drive. The excellent MPEG-2 decoding for this drive is performed by the *Cinemaster DVD Player* utility included with the Diamond video card. A consumer-grade 17-inch monitor, based on standard shadow mask technology, and offering a somewhat coarse .28-mm dot pitch, is included.

The audio system is wavetable, offering Aureal A3D surround sound. A set of Monsoon MC-200 speakers is also included. These consist of a pair of small satellite speakers with both conventional cone-technology drivers, as well as small planar drivers. The included subwoofer is very modestly sized, but does punch up the bass.

The Millennia Max 533B is interesting from a technological point of view, as it's one of the first Pentium IIIB-based systems to actually hit the market. However, it's also of interest because it offers performance close to a system based on the faster 550-MHz Pentium III, but priced as if it were a 500-MHz PIII. That's like getting something extra for free! P

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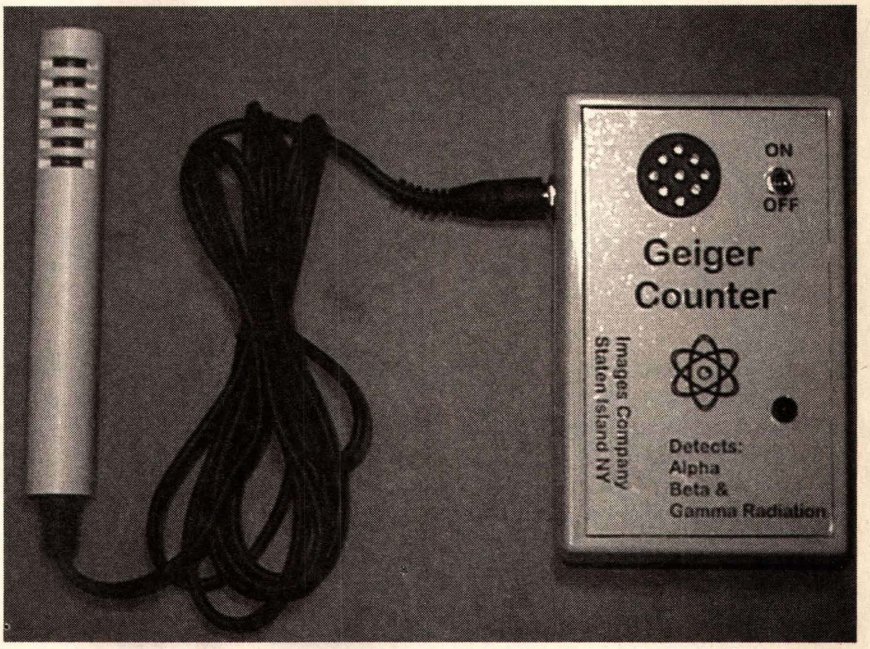
AMAZING SCIENCE

JOHN IOVINE

Geiger Counter

This month, we will build an inexpensive Geiger counter. Geiger counters are instruments that can detect and measure radioactivity. H. Geiger and E. W. Muller invented the Geiger counter (properly named the "Geiger-Muller counter") in 1928.

With a Geiger counter, you can check materials and environments for radioactivity. You could even go prospecting for uranium, if you wanted. The Geiger counter can also be used to check for radon in your basement. Radon, a slightly radioactive gas that seeps out of the earth, would show itself by increasing the radiation counts over what's called the "normal background" radiation.



Radioactivity

Radioactivity is the spontaneous emission of energy from the nucleus of certain elements, most notably uranium. There are three forms of energy associated with radioactivity: alpha, beta, and gamma radiation. The classifications were originally made according to the penetrating power of the radiation.

Alpha particles were found to be the nuclei of helium atoms; two protons and two neutrons bound together. Thanks to the presence of protons, alpha particles have a net positive charge. They are very weak when it comes to penetrating ability: a couple of inches of air or a few sheets of paper can effectively block them. In fact, your skin is an excellent alpha-particle shield. The danger of alpha particles comes when they get inside you, either by inhalation or ingestion. Once inside the body, they can accumulate and slowly do harm over a long period of time.

Beta particles were found to be free electrons, identical to the electrons found in atoms. Beta particles have a net negative charge. Their penetrating power is greater than alpha particles; 3 millimeters of aluminum is no problem to them.

Gamma rays (the most well-known radioactive energy to the general population) are high-energy photons. It has the greatest penetrating power of all of the various forms of radiation, being able to pass through several centimeters of lead and still be detected on the other side.

The Geiger counter that we'll be building is sensitive to all three types of radioactivity.

Geiger Tube

The Geiger-Muller (GM) tube has not changed much since it was invented in 1928. The operating principle is the same. A cutaway drawing of the tube is shown in Fig. 1. The wall of the GM tube is a thin metal cylinder that forms the cathode and surrounds a central anode. There is window made from a thin sheet of mica on the front end that lets the GM tube detect alpha particles. The tube is evacuated and filled with a combination of neon, argon, and halogen gases.

It is interesting to see how the GM tube detects radioactivity. A 500-volt

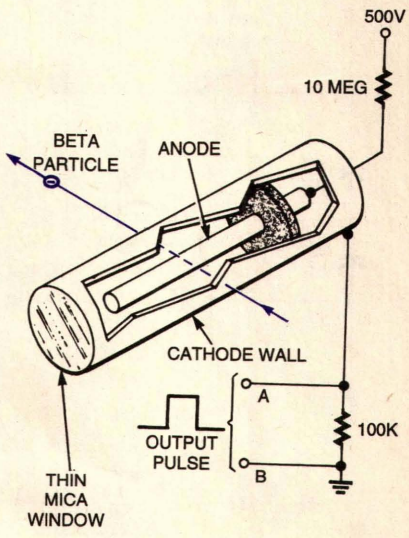


Fig. 1. When a radioactive particle passes through a Geiger-Muller tube, it ionizes the gasses within the tube. The positive and negative ions are attracted to the cathode and anode, respectively. In their mad dash to the electrodes, they ionize other gas molecules, creating an electrical path. The resulting electrical path from each particle will then create a short pulse on the tube's output.

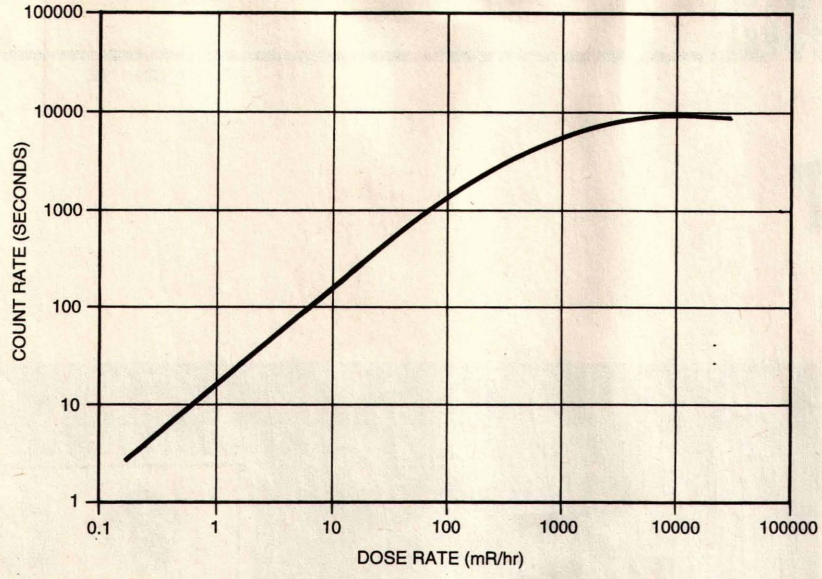


Fig. 2. There is a well-established relationship between the number of particles (measured in "counts" per second) being emitted and the radiation dosage (measured in millirads per hour). This chart is for the radioactive isotope Cesium-137

potential is applied to the anode through a 10-megohm current-limiting resistor. The cathode is grounded through a 100,000-ohm resistor.

Normally, the GM tube has a very high resistance. When a particle passes through the GM tube, it ionizes the gas molecules in its path, very much like the vapor trail left in a cloud chamber by a particle. In the GM tube, the electrons that are knocked free from the gas atoms by the particle and the remaining positive-ionized atoms both move rapidly towards the electrodes. In doing so, they collide with—and ionize—other gas atoms. That creates a small conduction path allowing a momentary surge of electric current to pass through the tube.

The momentary pulse of current appears as a small voltage pulse across R2. The halogen gas quenches the ionization and returns the GM tube to its high resistance state making it ready to detect another particle.

Count Rate *vs.* Dose Rate

Each output pulse from the GM tube is a count. The counts per second give an approximation of the strength of the radiation field. The GM tube is calibrated using cesium-137, the chart for which is shown in Fig. 2.

Schematic

The circuit, shown in Fig. 3, is powered by a 9-volt battery. The voltage is regulated to 5 volts by IC2, so as long as the battery voltage is above about 7 volts, the circuit will still work.

Four of the inverter gates of IC1 are set up as a squarewave generator; R8 adjusts the width of the squarewave. Those squarewaves switch Q1 on and off, which drives step-up transformer T1. The output of T1 is fed to a voltage

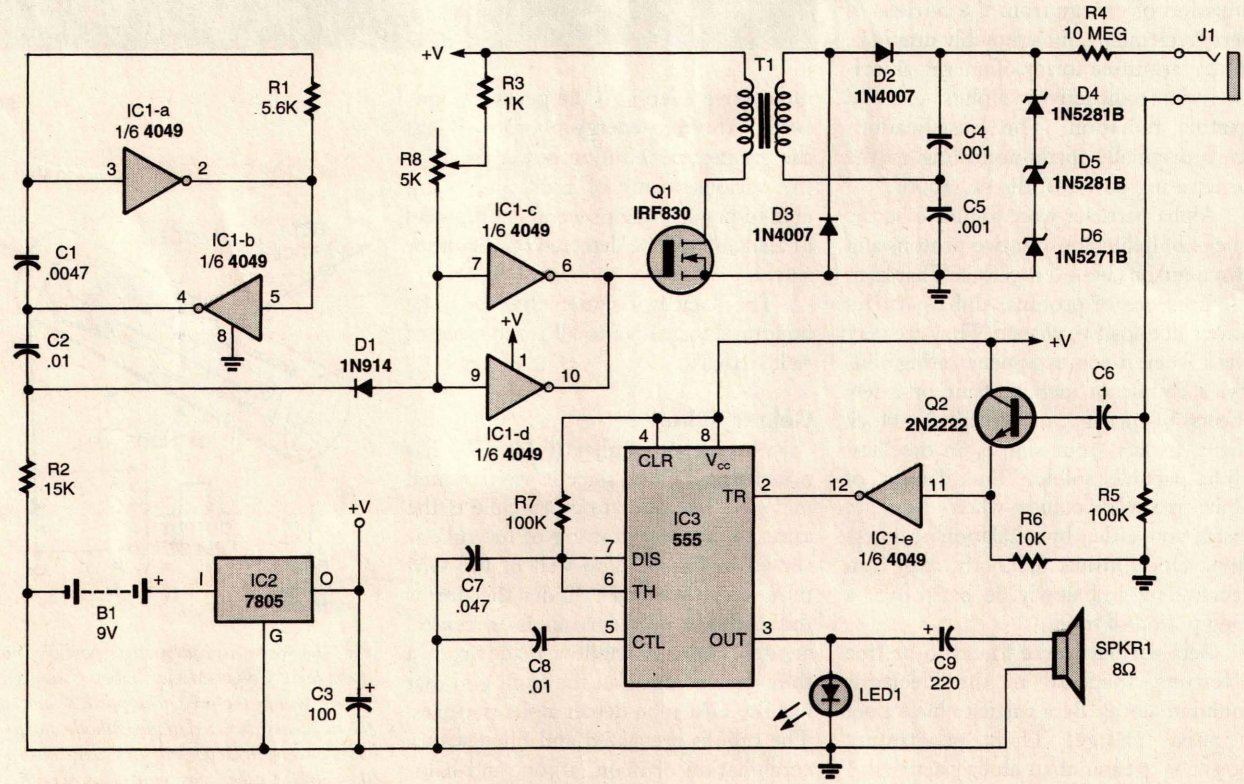


Fig. 3. The Geiger counter circuit supplies 500 volts to the Geiger-Muller tube (connected to J1) and indicates the detected radiation by clicking a speaker and flashing an LED; the pulses are "stretched" by IC3 so they can be seen.

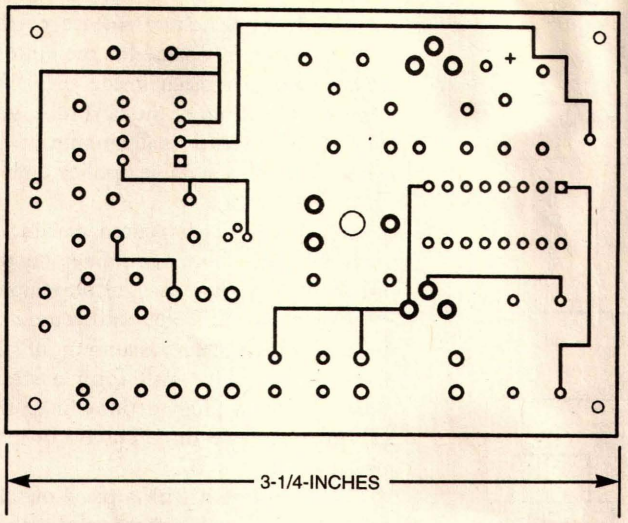


Fig. 4. The Geiger counter circuit uses a double-sided PC board for neater assembly. Here's the foil pattern for the component side.

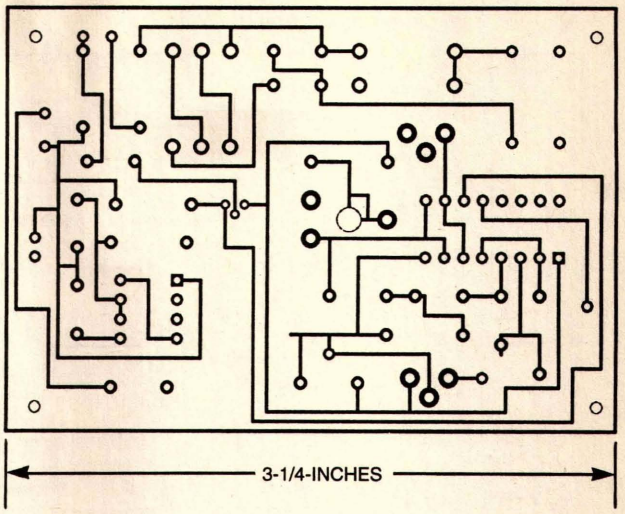


Fig. 5. With this foil pattern for the solder side of a double-sided PC board, wiring errors will be minimized—especially when working with high voltages!

doubler consisting of high-voltage diodes D2 and D3 and high-voltage capacitors C4 and C5.

By stacking a pair of 200-volt Zener diodes (D4 and D5) in series with a 100-volt Zener diode (D6), the high voltage output is regulated to 500 volts—the optimum voltage for our GM tube. The 500-volt output connects to the anode of the GM tube through R4 and J1. The 10-megohm resistor limits the current through the GM tube and helps quench the avalanched ionization.

The tube's cathode is connected to R5. The voltage pulse across R5 generated by the detection of radiation feeds the base of Q2 through C6. The NPN transistor clamps the output pulse from the GM tube to the 5-volt level of the power supply. That signal is inverted by one of the extra gates on IC1 and triggers IC3, an LM555 timer chip that is set up as a one-shot. The stretched pulse from the timer flashes LED1 as well as clicking SPKR1.

PARTS LIST FOR THE GEIGER-MULLER COUNTER

SEMICONDUCTORS

IC1—CD4049 hex-inverting buffer, integrated circuit
IC2—LM7805 5-volt fixed voltage regulator, integrated circuit
IC3—LM555 timer, integrated circuit
Q1—IRF830 N-channel MOSFET transistor
LED1—Light-emitting diode, red
D1—1N914 small-signal silicon diode
D2, D3—1N4007 1000-volt, 1-amp silicon rectifier diode
D4, D5—1N5281B 200-volt Zener diode
D6—1N5271B 100-volt Zener diode

RESISTORS

(All resistors are 1/4-watt, 5% units unless otherwise noted.)
R1—5600-ohm
R2—15,000-ohm
R3—1000-ohm
R4—1-megohm
R5, R7—100,000-ohm
R6—10,000-ohm
R8—5000-ohm PC-mount potentiometer

CAPACITORS

C1—0.0047-μF, ceramic-disc
C2, C8—0.01-μF, ceramic-disc
C3—100-μF, 12-WVDC electrolytic
C4, C5—0.01-μF 1000-volt ceramic-disc
C6—1-μF, 12-WVDC electrolytic
C7—0.047-μF, ceramic-disc
C9—220-μF, 12-WVDC electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—9-volt battery
J1—1/4-inch phone jack
SPKR1—8-ohm speaker
T1—Step-up transformer, PC-mount
Geiger-Muller tube, case, LED holder, on-off switch, battery connector, shielded wire, 1/4-inch phone plug, grommet, plastic pipe, hardware, etc.

Note: The following items are available from Images Company, 39 Seneca Loop, Staten Island NY 10314; Tel. 718-698-8305; Web:*www.imagesco.com*: Complete kit of all components, $149.95; Geiger-Muller tube, $ 48; Printed-circuit board, $15; T1, $5; PVC pipe cut to length with louvers, $10; Cesium-137 1-microcurie radioactive source, $55; S-7 source set includes Polonium-210 (0.1-microcurie alpha source), Strontium-90 (0.1-microcurie beta source), and Cobolt-60 (1-microcurie gamma source), $ 125. New York State residents must add appropriate sales tax.

Construction

There is nothing critical about the circuit; you may hand-wire it on a piece of perfboard. Using a printed-circuit board, on the other hand, makes the construction that much easier. If you want to go that route, top and bottom foil patterns for a double-sided board are provided in Figs. 4 and 5, respectively. If you do not want to etch your own board, one can be obtained from the source given in the Parts List. If you use a PC board from either source, follow the parts-placement diagram shown in Fig. 6.

We'll begin construction with the squarewave generator, pulse-shaping circuit, and low- and high-voltage power supply sections. Install C1–C5, C9, D1–D3, IC1, IC2, R1–R3, R8, and T1. Be sure that C4 and C5 are high-voltage capacitors; components that are subject to voltages beyond their ratings tend to do nasty things like smoke, explode, and burst into flames!

Before continuing, adjust the high-voltage power supply. Set up a voltmeter to read 500 to 1000 volts. Place the positive lead of the meter at the junction of C4 and D2 and the negative lead to

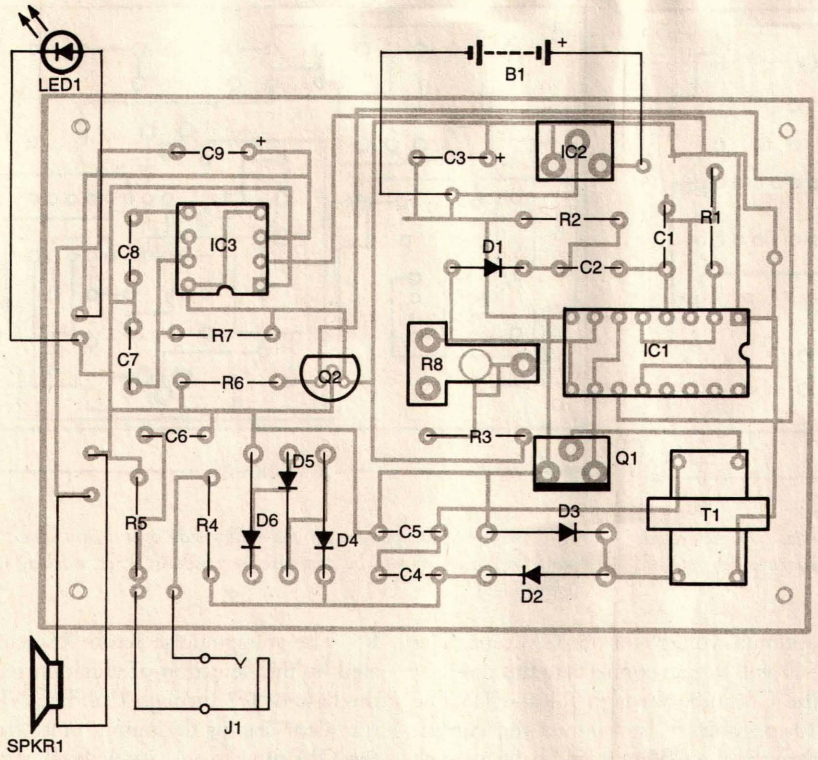


Fig. 6. If you use a PC board for the Geiger counter, use this parts-placement diagram for component location. While it is not shown, you might want to add a single-pole, single-throw switch in series with the positive lead of B1 to act as an on-off switch.

ground. Apply power and adjust R8 for the peak voltage output. Remember, you're dealing with very high voltages—use caution! You should be able to generate 700 volts or more. Once the circuit is adjusted, turn off the power and install D4–D6. Apply the power again; the junction of C4 and D2 should now read 500 volts. If you're not getting a proper reading, check the zener diodes to make sure that you have them oriented in the right direction.

Once the power supply is working, finish construction by adding the remainder of the components to the board. Mount the finished board in any suitable plastic enclosure large enough to hold everything. Adding an on-off switch in series with the positive lead of B1 is a good idea; mount that switch on the top of the case along with LED1. You can drill a larger hole or a series of smaller holes for SPKR1. My prototype used a flat piezo-electric speaker with a plastic frame. I glued the speaker to the top on my enclosure. Don't forget to drill a hole in the side of the enclosure for J1.

GM Tube Holder

The Geiger-Muller tube is delicate and needs to be protected in an enclosure. However, the tube enclosure should allow the front end of the tube to remain open so that alpha particles can make their way through the thin mica window and be detected.

A suitable enclosure can be made from a piece of plastic PVC pipe about six inches long with a 1/2-inch inside diameter. Cut a series of louvers or slits in one side of the PVC pipe to let beta radiation access to the GM tube unimpeded. The arrangement is shown in Fig. 7.

Solder the center wire of a length of shielded cable to the solder clip that is attached to the center electrode of the tube. The wire's shield goes to the wire connected to the metal wall of the GM tube. To prevent a short between the two GM tube wires, cover one or both with shrink tubing, silicone sealant cement, or corona dope.

Insert the GM tube inside the PVC pipe so that the tube lies 1/4-inch away from the end with the louvers. Glue the GM tube in position with the type of silicone sealant cement that is used to construct and repair aquariums. That type of cement fills spaces between surfaces and when it cures, still retains a degree of flexibility. Apply the glue just to the outer perimeter of the top of the GM tube and the matching surface of the PVC pipe. Do the same for the bottom of the tube. To reach inside the PVC pipe to the bottom of the GM tube, you will need to place a small amount of silicone glue on a suitable applicator like an ice-cream stick.

When this glue has cured, place a 1/2-inch-diameter rubber grommet on the shielded cable. Slide the grommet up to and inside the PVC pipe and secure it in position with a generous amount of silicone sealant. That will form a strain relief. Solder a plug to the end of the cable that mates with J1; I used a 1/4-inch phone plug.

Finish the unit with a piece of self-adhesive hook-and-loop material such as Velcro. One part goes on the side of the PVC pipe and its mating part to the side of the case. That lets you attach the GM tube wand to the case.

Radioactive Sources

Ionization-type smoke detectors use a radioactive alpha source, Americium-241; the main reason that they are highly regulated in terms of disposal. To use the Americium as a calibration source, you need to remove it from the smoke detector. As I said before, alpha particles only travel a few inches in open air, so you need to get pretty close to the source with the GM tube to detect anything.

Again, heed the warnings about accidentally inhaling or ingesting alpha particles. If you have to get your face that close to the source, you should consider a pair of goggles and a facemask. You should also be mindful of any open cuts or bruises on your skin. While it might seem to be extreme measures when working with such a weak alpha-particle source, remember that we're talking about your long-term health here. Always think "safety first!" when dealing with radioactivity.

The mantle in some Coleman lanterns is radioactive. Bring your Geiger counter to a local hardware store and check them out on the shelves. You may want to consider purchasing one of these "hot" lanterns as a source for use in future radiation experiments and calibrations.

Uranium ore from a mineral or rock store should also emit sufficient radiation to trigger the counter.

A more reliable method is to purchase a radioactive source. Small amounts of radioactive materials are

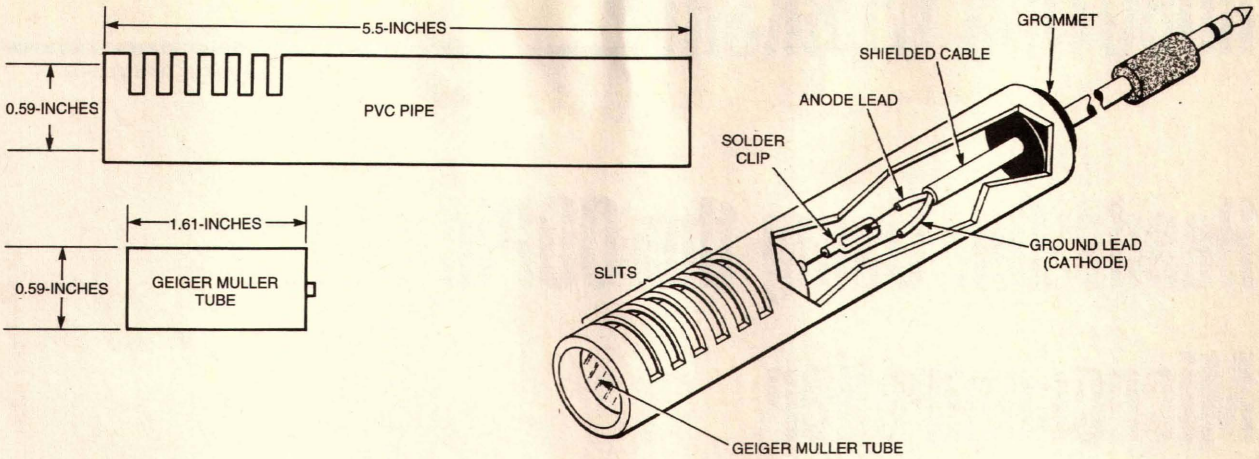


Fig. 7. The Geiger-Muller tube is delicate; glue it into a length of plastic pipe available at most plumbing supplies or home-improvement stores. Don't forget to cut a series of slots in the pipe as shown so beta particles can penetrate the tube.

available for sale encased in 1-inch diameter by 1/4-inch-thick plastic disks. The disks are available to the general public without requiring a license. Since the material outputs radiation in the micro-curie range, the Federal government deems it safe.

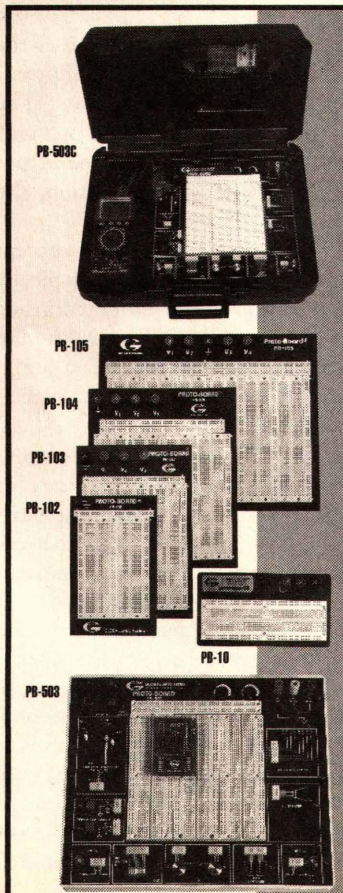
Cesium-137 is a good gamma-ray source. It has a half-life of 30 years, meaning that in 30 years, 50% of the isotope will have decayed into a stable, non-radioactive element.

Check Out

Turn on the Geiger counter. If you have a radiation source, bring the GM tube close to it. The radiation will cause the Geiger counter to start clicking. The LED will pulse with each click. Each click represents the detection of one radioactive ray (alpha, beta, or gamma).

Background Radiation

Background radiation from natural sources on earth and cosmic rays will cause the Geiger counter to click. In my corner of the world, I have a background radiation that triggers the counter 12–14 times a minute. You may be surprised at what you find in your neck of the woods. P



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Hands On: Using the OOPic Microcontroller

In last month's column, we looked at the OOPic, a new and affordable microcontroller from Savage Innovations. OOPic—which stands for *O*bject-*O*riented *P*rogrammable *I*ntegrated *C*ircuit—is ideally suited for robot building. It provides as built-in features many of the functions most often required for robotics.

Those functions include pulse-width modulation that can be readily used for controlling the speed of DC motors, analog-to-digital conversion for reading sensor values, and built-in servo support for operating any standard radio-controlled (R/C) servo. The OOPic provides those functions as predefined programmed objects. Instead of writing your own code to perform those tasks, you merely tap into the OOPic's bag of objects and off you go!

In this month's column, we'll continue our look at the OOPic, including using it to control both unmodified and modified servos as well as a standard four-phase stepper motor. Along the way, we'll talk about the OOPic's unique "virtual circuit" feature, which allows you to construct electronic circuits—such as logic gates, inverters, and flip-flops—using only programming code.

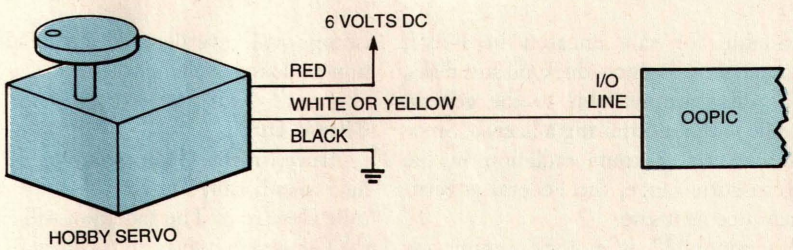


Fig. 1. Follow this basic wiring diagram to connect a standard R/C servo to the OOPic. Most servos use consistent color coding for their wiring: black for ground, red for +V, and yellow or white for the input signal.

Using the OOPic to Control a Servo

Though R/C servos are meant for model airplanes, boats, and cars, they are equally useful for robotics applications. Servos are inexpensive—basic models cost under $15 each—and combine in one handy package a DC motor, gearbox, and control electronics. The typical servo is designed to rotate 180 degrees (or slightly more), in order to control the steering wheel on a model car or the flight-control surfaces on an R/C airplane. For robotics, a servo can be connected to an armature to operate a gripper, to an arm or leg, or just about anything else you can imagine.

Let's review the operation of servos to better understand how to connect them to the OOPic. An R/C servo consists of a reversible DC motor. The high-speed output of the motor is geared down by a series of cascading reduction gears; the gears can be made out of plastic, nylon, or metal (usually brass, but sometimes aluminum). The output shaft of the servo is connected to a potentiometer, which serves as a closed-loop feedback mechanism. A control circuit in the servo uses the potentiometer to accurately position the output shaft.

Servos use a single pulse-width-modulated (PWM) input signal that provides all the information needed to control the positioning of the output shaft. The pulse width varies from a nominal 1.25 milliseconds to roughly 1.75 milliseconds, with 1.5 milliseconds representing the "center" (or neutral) position of the servo-output shaft (note that servo specs vary; these are typical). Lengthening the pulse width causes the servo to rotate in one direction; shortening rotates the shaft the other way. The potentiometer position acts to "null out" the input pulses, so that when the output shaft reaches the correct location, the motor stops.

R/C servos are engineered to accept a standard TTL-level signal, typically coming from a receiver mounted inside a model car or airplane. The OOPic can interface directly to an R/C servo, and it requires no external components such as power transistors.

You can theoretically control up to 31 servos with one OOPic—one servo per I/O line. However, a practical maximum is about 12 to 15 servos. The reason is that servos require a constant stream of pulses to accurately hold their position. The ideal pulse stream is at 30–60 Hz, which means that each servo that is connected to the OOPic must be "updated" 30 to 60 times per second. The OOPic is engineered to provide pulses at 30 Hz intervals; with more than about eight servos, the refresh rate is reduced to 15 Hz. While most servos will still function at that low rate, a kind of "throbbing" can occur if the servo is

under load.

Though some robotic projects call for controlling a half-dozen or more servos like the six-legged Hexapod II from Lynxmotion (12 servos working in tandem), the typical experimental robot uses only two or four servos. The OOPic is ideally suited for that task; programming for it is easy. To operate a servo, you need only provide a few lines of setup code, then indicate the position of the servo using a positioning value from zero to 63. That value corresponds to the 0- to 180-degree movement of the servo's output shaft.

With 64 steps, the OOPic is able to position a servo with a 2.8-degree accuracy. That assumes a maximum rotation of 180 degrees (not all servos can do that). Note that if you need greater resolution than that, you can make use of the OOPic's built-in pulse-width modulation object, which can be programmed to provide your servos with far greater positional accuracy. However, for most applications, the OOPic's servo object provides adequate resolution and is easier to use.

Listing 1 shows a program written in the OOPic's native Basic syntax, demonstrating how to control an R/C servo using the oSERVO object. Software is only half of the equation; Figure 1 shows how to connect the servo hardware to the OOPic. Although most hobby R/C servos are designed for a supply voltage between 4.5 and 7.2 volts DC, you should use separate power supplies for the OOPic and the servo. Most servos draw considerable current while turning, and that current drain can cause the supply voltage of an undersized six-volt battery pack to sag below the 4.5-volt level required by the OOPic. When the voltage drops below that level, the OOPic's built-in brownout circuit kicks in, resetting the processor. That repeats continuously, the net effect being a nonfunctioning circuit.

One alternative is to power the whole shebang from a single 9- or 12-volt supply, but higher voltages mean over-powered servos. Not all servos are built to handle the extra speed and heat caused by the higher voltages, and an early death of your servos could result. Therefore, it's best to use two different batteries. The OOPic is fine operating from a single 9-volt transistor battery; run the servo from a set of four "AA" batteries.

The first three lines in Listing 1

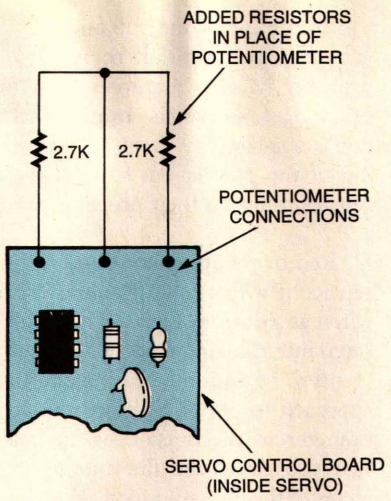


Fig. 2. To modify a servo, you must replace the internal potentiometer with two 2700-ohm resistors wired as shown here.

"dimension" (or create in memory) the objects used in the OOPic program. S1 is the servo object; "x" and "i" are simple data objects that hold eight and four bits, respectively. The program itself begins with the MAIN subroutine, which is automatically run when the OOPic is first turned on or reset. The first order of business is to call the SETUP subroutine, located at the end of the program. There, the program establishes I/O line 31 (pin 26 of the OOPic chip) as being connected to the control input of the servo.

The servo is then centered using a value of 31 (half of 64, considering 0 as the first valid digit); you need to experiment to find the mechanical center of the servo you are using. Each servo, particularly those of different sizes and from different manufacturers, can have a different mechanical center. Adjust the centering value up or down accordingly. Finally, the servo object is activated using the statement

S1.OPERATE = CVTRUE

Note the use of properties when working with the OOPic's objects. Properties are defined by specifying the name of the object, such as S1 for "Servo 1," a period (known as the *member operator* in programming parlance), and then the property name. Thus, S1.IOLINE sets (or reads) the IO line property for the S1 object. Similarly, S1.CENTER sets the center property, and S1.OPERATE turns the S1 object on or off. For most OOPic properties, you can both read their values and write values to them. A few are read-only or write-only.

Once the servo is set up, you can manipulate it using the S1.VALUE property. In our demonstration program, the VALUE property is inferred, as it is the so-called "default" property for servo objects. Therefore, it is only necessary to specify the name of the object, and the value you want for it:

S1 = 0

Listing 1

```
' OOPic servo demonstrator
' Uses a standard R/C servo

' This program cycles a servo, connected
    to IOLine 31,
'   for full rotation (0 to 180 degrees)

' Dimension needed objects
Dim S1 As New oServo
Dim x As New oByte
Dim i As New oNibble

'_____
_____
'First routine called when power is
    turned on
Sub Main()
Call Setup  ' set up servo properties
For i = 1 to 5          ' repeat motions five
                          times
   S1 = 0               ' set servo to 0
                          degrees, and wait a
                          while
   Call longdelay
   1 = 63               ' set servo to 180
                          degrees, and wait a
                          while
   Call longdelay
Next i
End Sub

'_____
_____
' Delay loop routine
Sub longdelay()
For x = 1 To 200:Next x
End Sub

'_____
_____
' Setup routine
Sub Setup()
S1.Ioline = 31          ' Set servo
                          to I/O line 31 (pin 26)
S1.Center = 31          ' Set center to 31
                          (experiment for best
                          results)
S1.Operate = cvTrue ' Turn servo on
End Sub
```

sets the servo all the way one direction, and

S1 = 63

sets the servo all the way in the other direction. Because the VALUE property is the default for the OSERVO object, the statement S1 = 63 is the same as writing S1.VALUE = 63.

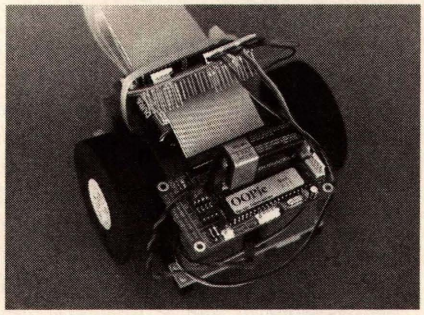


Fig. 3. You can construct a demonstrator for the OOPic with a two-wheel robot using toy plastic interlocking bricks. The servos are glued to small interlocking brick parts to aid in mounting.

Exercise care when playing around with servos. Not all servos can travel a full 90 degrees from center, especially if you have not properly set the mechanical center using the S1.CENTER property. For initial testing, use values slightly higher than 0 and slightly lower than 63 to represent the minimum and maximum servo movements. Otherwise, the OOPic may command the servo to move past an internal stop position, which can cause the gears to slip and grind. Left in that state, the servo can be permanently damaged.

Operating Modified Servos

As designed, R/C servos are meant to travel in a limited rotation up to 90 degrees to either side of some center point. By modifying the internal construction of the servo, it's possible to make it turn freely in both directions, operating like a regular, geared DC motor. This modification is handy when you want to use servos for powering your robot across the floor.

Different servos require different steps in order to modify them, but the general process is about the same, as you can see below:

Open the servo to expose the gear train, motor, and potentiometer, by removing the screws on the back of the case.

File or cut off the nub on the output gear that prevents full rotation. You'll probably have to remove one or more other gears, so exercise caution that you don't misplace any parts. Make a drawing of the gear layout so that you can replace things in their proper location.

Remove the potentiometer, and replace it with two 2700-ohm resistors, wired as shown in Fig. 2. That fools the servo into thinking that it's always in the "center" position. An even better approach would be to move the potentiometer to the outside of the case so that you can make fine-tuning adjustments of the center position. Alternatively, you can attach a new 5000- or 10,000-ohm potentiometer to the circuit board inside the servo.

Finally, reassemble the case.

See *www.seattlerobotics.org/guide/servhack.html* for a step-by-step tutorial on modifying a commonly available Futaba S-148 servo for continuous rotation. Note that some servos—namely the popular Hi-Tech HS-300—are designed with the potentiometer serving double-duty as the output shaft. You must disassemble the potentiometer to remove its internal stop and clip off its electrical connections from the servo's control board.

Once modified, you can connect the servo to the OOPic in the same manner as an unmodified servo (see Fig. 1). Listing 2 shows how to use the OOPic with two modified servos acting as the drive motors for a two-wheeled robot. You can readily construct a demonstrator robot using toy plastic building-block parts like the prototype shown in Fig. 3. I cemented two lightweight R/C airplane wheels to the control horns that come with the servos. I also cemented a flat plate from the toy building-block set to the side of each servo to aid in snapping the motors to the building-block frame of the robot.

Batteries and the OOPic are attached to the top of the robot using double-sided tape. A 9-volt battery powers the OOPic; power to both servos is provided by a 6-volt pack of AA batteries. Note that I used a wire-wrap board as a terminal bus and that standard 0.1-inch-center connectors were used instead of hard-soldering any wiring to the various components. That makes it easier to test the robot and possibly add to it at a later date.

On the Web

OOPic Home Page, Savage Innovations
The OOPic retails for $39 (the OOPic Starter Kit is $49, and includes programming cable and battery clip).
www.oopic.com

R/C servo fundamentals
www.seattlerobotics.org/guide/servos.html

Modifying R/C servos to full rotation
www.seattlerobotics.org/guide/servohack.html

Definitive guide to stepper motors
www.cs.uiowa.edu/~jones/step/index.html

Lynxmotion Hexapod II
www.lynxmotion.com

The program in Listing 2 is a modified version of Listing 1. Its main difference, other than employing two OSERVO objects instead of one, is that the "center" position is used to turn the motor off. Values greater than this center position cause the servos to rotate in one direction; values less than the center position cause the servos to rotate in the opposite direction.

Note that in Listing 2 the "normal" direction of travel for servo 2 (S2) is reversed from S1, with the statement

S2.INVERTOUT = CVTRUE

That is handy because in the two-wheeled robot, the servos are mounted on opposite sides, so one motor must turn clockwise while the other turns counter-clockwise in order to move the robot forward or backward. Without the INVERTOUT property, you'd have to set

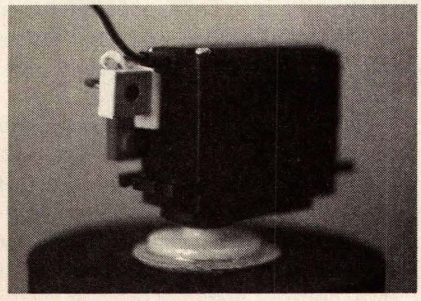


Fig. 4. This servo has been modified with a small 5000-ohm trimmer potentiometer to replace the one removed from the servo. It is mounted to the outside of the servo case with double-sided tape. The potentiometer allows easy calibration to find the servo's center, or neutral, position.

Listing 2

```
' OOPic two-motor (servo) robot
    demonstrator
' Requires the use of modified R/C servos
    (see text)

' This program cycles the robot through
    various movements,
'   including forward, backward, right spin,
    left spin,
'   and turns.

' Dimension objects
Dim S1 As New oServo
Dim S2 As New oServo
Dim CenterPos as New oByte
Dim Button As New oDio1
Dim x as New oByte
Dim y as New oWord

'-------------------------------------------
-----------
Sub Main()
CenterPos = 31          ' Set centering of
                        servos
Call Setup
Do
   If Button = cvPressed Then
          ' Special program to calibrate
          servos
          S1 = CenterPos
          S2 = CenterPos
   Else
          ' Main program (IO line is held
          low)
          Call GoForward
          y = 200       ' Same as
                        LongDelay
          Call Delay    ' Alternative to
                        LongDelay

          Call HardRight
          Call LongDelay

          Call HardLeft
          Call LongDelay

          Call SoftRightForward
          Call ShortDelay

          Call SoftLeftForward
          Call ShortDelay

          Call GoReverse
          Call LongDelay
   End If
Loop
End Sub

'-------------------------------------------
-----------
' Set up IO lines and servos
Sub Setup()
Button.Ioline = 7           ' Set IO Line 7 for
                            function input
Button.Direction = cvInput  ' Make IO Line 7
                            input
S1.Ioline = 30              ' Servo 1 on IO
                            line 30
S1.Center = CenterPos       ' Set center of
                            Servo 1
S1.Operate = cvTrue             ' Turn on
                                Servo 1
S2.Ioline = 31              ' Servo 2 on IO
                            line 31
S2.Center = CenterPos       ' Set center of
                            Servo 2
S2.Operate = cvTrue             ' Turn on
                                Servo 2
S2.InvertOut = cvTrue       ' Reverse direc-
                            tion of Servo 2
End Sub

'-------------------------------------------
-----------
' Short delay routine
Sub ShortDelay()
   For x = 1 To 80:Next x
End Sub

'-------------------------------------------
-----------
' Long delay routine
Sub LongDelay()
   For x = 1 To 200:Next x
End Sub

'-------------------------------------------
-----------
' Selectable delay routine
Sub Delay()
   For x = 1 To y:Next x
End Sub

'-------------------------------------------
-----------
' Motion routines (forward, back, etc.)
' "Hard" turns spin robot in place
' "Soft" turns turn robot right or left in
    forward
'   (or backward) motion
'-------------------------------------------
-----------

Sub GoForward()
S1 = 0
S2 = 0
End Sub

Sub GoReverse()
S1 = 63
S2 = 63
End Sub

Sub HardRight()
S1 = 0
S2 = 63
End Sub

Sub HardLeft()
S1 = 63
S2 = 0
End Sub

Sub SoftRightBack()
S1 = CenterPos
S2 = 63
End Sub

Sub SoftRightForward()
S1 = 0
S2 = CenterPos
End Sub

Sub SoftLeftBack()
S1 = 63
S2 = CenterPos
End Sub

Sub SoftLeftForward()
S1 = CenterPos
S2 = 0
End Sub
```

the VALUE property of one servo to 0 and the other to 63, in order to maintain proper forward or backward motion.

Not shown in Listing 2 is a useful feature that you may want to use: Values very close to the center position (within about five steps) will cause the servos to slow down by a proportional amount. For example, if the center position is 31, then a value of 32 for S1 or S2 will rotate that servo clockwise very slowly; higher values will modestly increase the speed in the same direction of travel. Conversely, a value of 30 for the S1 or S2 object will have the same effect but in the counterclockwise direction. A value of 29 would make the motor go a little faster, and so on.

Listing 2 takes the robot through a series of patterned moves, including forward and backward movement, right and left spins, and turns. Delay routines let you specify how long each movement will last. Vary the delay up or down to experiment with different motions. In the prototype, the program in Listing 2 moves the robot back and forth about two feet. The program repeats itself until you reset the OOPic or disconnect the power.

Note the close-up of the modified servo in Fig. 4. The potentiometer that is attached to the case of the servo with a small piece of double-sided foam tape serves as an accurate voltage divider to set the center, or neutral, position of the servo. You set the potentiometers by taking I/O line 7 high. The program in Listing 2 then runs an alternative routine in its MAIN loop so that you can set the center property of both servos to a value of 31. The potentiometers are then adjusted so that the motors just stop. Using the potentiometer makes it much easier to calibrate the servos for use with the program. Once calibrated, you can tie I/O line 7 low again.

Controlling Stepper Motors

The OOPic is full of pleasant sur-

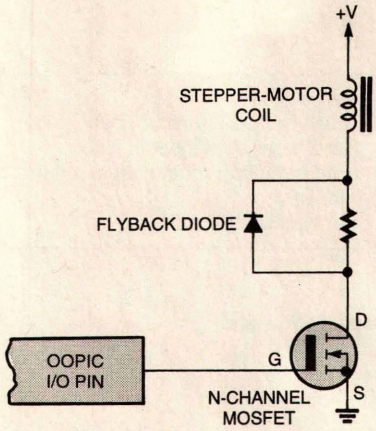


Fig. 5. One way to interface the OOPic to a stepper motor is to use power MOSFETs, as shown here. The diodes help protect the outputs of the MOSFETs from spikes, induced by the back-EMF generated by the stepper motor windings.

prises, including the innate ability to control a standard four-phase unipolar stepper motor. Unlike R/C servos, however, the OOPic is not able to directly drive a stepper motor; for that you'll need an interface with a current and voltage rating for the stepper motor that you are using. Figure 5 shows a simple interface using an IRF511 or IRF630 power MOSFET transistor, suitable for driving most any stepper motor with a per-phase current rating of about 1 to 1.5 amps. Don't leave out the diode; it protects the MOSFET from back EMF generated by the windings of the stepper motor. As I mentioned before, the type of stepper motor that we're going to hook up to the OOPic has four coils, so you'll need four identical circuits—one for each coil.

The motor should be powered from a separate power supply, rated at least twice the per-phase current rating of the motor. For example, if each phase of the motor pulls 1.25 amps, the power supply must be rated at no less than 2.50 amps, preferably more. At times, there will be two coils energized at the same time.

Listing 3 shows a simple stepper-motor-driving program, using a feature unique to the OOPic: virtual circuits. Instead of programming each of the four phases of a stepper with on/off values in code, the program uses two processing objects, oCONVERTER and oCOUNTER. Processing objects are used to construct virtual circuits, which are like real electronic circuits, only they are created solely using programming statements.

The stepper-motor program in Listing 3 demonstrates one of the uses for the oCONVERTER numeric-conversion object, which has a built-in "behavior" of being able to construct the proper phasing to control the forward and backward rotation of a four-phase unipolar stepper motor. The program also uses a counter object, which allows you to define the number of steps that you wish to apply to the motor. Keep in mind that the oCONVERTER object specifies an eight-phase cycle, which has the effect of moving the motor in half-step increments, improving the accuracy and torque of the motor. So, for example, if the motor is rated at 200 steps per revolution, it will require 400 pulses from the OOPic to turn it a full 360 degrees.

Experiment with the OOPic and you'll find that it's a capable performer in the field of robotics. By judicious use of its objects, coupled with a liberal sprinkling of virtual circuits, you should be able to construct most any kind of robotic creature, using a minimum number of external components. P

Listing 3

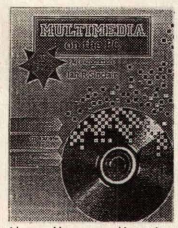
```
' OOPic stepper motor demonstrator
' Uses a standard four-phase unipolar stepper motor
' Operates motor in half-stepping mode

' Dimension objects
Dim Stepper as New oDio4    ' 4-bit IO for controllering stepper
Dim Driver as New oConverter
Dim Position as New oWord   ' 32-bit value for current position
Dim Mover as New oCounter

'-------------------------------------------------------
Sub Main()
Call Setup
' The rest of your code here

' To reverse motor, use Mover.Direction = cvNegative
'   or Mover.Direction = cvPositive
' To stop-and-hold motor, use Mover.Operate = cvFalse
' To restart motor, use Mover.Operate = cvTrue
' To stop and de-energize motor, use Driver.Blank = 1
End Sub

'-------------------------------------------------------
' Set up stepper motor
Sub Setup()
Stepper.IOGroup = 1             ' Set stepper to use IO group 1 (pins 8-11)
Stepper.Nibble = 0              ' Picks lower 4 lines from IO group
Stepper.Direction = cvOutput    ' Make lines outputs
Driver.Output.Link(Stepper.Value)       ' Set up virtual circuit for driver x-lation
Driver.Input.Link(Position.Value)
Driver.Mode = cvPhase
Driver.Operate = cvTrue
Mover.ClockIn1.Link(OOPic.Hz60)         ' Use OOPic 60 Hz object for stepping
Mover.Output.Link(Position.Value)
Mover.Operate = cvTrue          ' Enable counter
End Sub
```

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MA02

TECH MUSINGS

DON LANCASTER

Fitting Bezier Curves, Machine-Tool Interface Details, PIC and Basic Stamp Books, and More

Let the megapixel wars begin! Digital cameras are getting quite good, and soon should blast their way right on past traditional film photography. But I'm wondering if an obvious product is not being missed out on big time.

Let's call it a *scamera*.

We have seen in previous columns how a better-grade scanner can take digital photos at up to 170 megapixels and even higher resolutions. Observe that 1200 DPI × 1200 DPI × 8.5 inches × 14 inches = 171.36 megapixels. That level of resolution is done with only 10,200 actual light sensor cells!

Why? Because a scanner needs only a single line of n cells, while a digital camera needs an array of n × m cells.

The only tiny problems with my scanner techniques are the "straight-on" format; the limited depth of field; subject restrictions; and the dropoff of sharpness, brightness, and contrast with glass distance. But, given any suitable subject, your results can totally blow digital cameras away, especially on product lettering. See *www.tinaja.com/barg01.html* for dozens of examples.

What I am wondering is why we can't have the best of both worlds. Put a lightweight line sensor and a tiltable mirror on the back of a larger camera. Presto! Low-cost megapixels that have few subject limitations at least for subjects that are willing to sit still for a second or so.

With a cheaper light sensor, there is no reason why a scamera should not cost a lot less than conventional consumer-grade digital cams while giving ridiculously better results.

Another thing many cameras miss out on is that they seem to blindly insist upon immediately JPEG compressing (and thus trashing up) your images. JPEG seems especially adept at making any small lettering illegibly ugly. It also seems to want to create blotches. A raw bitmap output option should be provided for those who'll demand the best quality, even if you could only store one picture at a time. JPEG or other compression is best done only *after* you have gotten your image precisely the way that you want it.

Hanging a new scanner on a litho camera's ground glass might lead to some interesting possibilities if the lighting levels and depth of field can be worked out.

Be sure to watch for JPEG-2000, which includes wavelets and should dramatically ease artifacts. This new scheme promises better images and denser compression, brought about in part by exploiting unviewable color differences that were ignored in the original JPEG specification. From three to five times denser compression is expected.

Let's have your thoughts on routes to effective digital photography.

NEED HELP?

Phone or write all your US Tech Musings questions to:

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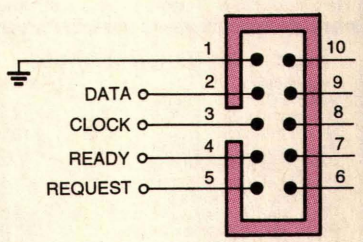

Fig. 1. The connector pinouts for the Mitutoyo Digimatic machine-tool gauge interface use a standard 2- by 5-pin header; it can be used with a ten-conductor flat cable.

Some More Digimatic Info

We started to look at machine-tool-to-computer interfaces back in the "Tech Musings" column that appeared in the December 1999 issue of **Electronics Now**. Apparently, the crucial spec for the most popular interface is found in a "Manual Number 4330" from Mitutoyo; it is titled the "Digimatic Code Output I/F Specifications."

That code sends measurement information from a micrometer—height gauge, caliper, or whatever—to a host display or CAM (computer-aided manufacturing) system for SPC (statistical process control) or other interface needs.

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TABLE 1
DIGIMATIC PIN FUNCTIONS

Pin	Name	Function Description
1	Ground	Electrical Reference
2	Data	When requested, 52 bits are provided by the gauge. Format is thirteen four-bit nibbles.
3	Clock	Provided by the gauge to indicate that data is valid on the rising edge.
4	Ready	An active-low signal that the gauge outputs several times a second when a measurement is available.
5	Request	An active-low output from the host if data is wanted. It must follow the gauge's READY signal.

The pinouts of the 2- by 5-pin rectangular header-style connector are shown in Fig. 1 with info on each pin's function detailed in Table 1. That connector, with its 1/10-inch-spacing pins, is directly compatible with a stock ten-conductor flat cable. Only the first five pins are used in the basic interface. Inputs sent to the measuring instrument are all CMOS compatible and are forced normally high by a 20,000-ohm resistor. There's also a second series 20,000-ohm resistor and a 100-picofarad capacitor that acts as an input-noise filter. The high-frequency input impedance is thus around 10,000 ohms or so.

Outputs from the instrument are open-collector NPN transistors or open-source N-channel FETs. Note that the signals at the connector are active low.

Handshaking works like this: Several times each second, the gauge sends out a low READY signal. If the computer host wishes to see data, it can respond at any time within eighty milliseconds by pulling the REQUEST line low. Your gauge then answers by outputting a 52-bit data sequence. Each clock pulse stays a minimum of 100 microseconds high and then has to remain 100 microseconds low for a 5-kHz maximum clock rate.

While the data is valid during the entire clock low time, it should get entered into an interface on the *rising* edge of the clock. Clocking continues until all 52 data bits are output.

Figure 2 shows us a traditional commercial interface. Pairs of gauge instrument cables are combined and converted to a RS232C serial communications line.

Timesharing games can be played to multiplex eight or more instruments onto one RS232 port. I sometimes have a few surplus interfaces available at *www.tinaja.com/barg01.html*. It seems reasonable to expect any newer interfaces to go the USB route instead of RS232.

You will find the Digimatic data format in Fig. 3. Data is grouped into thirteen sequential *nibbles* (half a byte) of four bits each. All of the data bits in each nibble will arrive with the least-significant bit first.

Fig. 2. Here is a typical older Digimatic-to-computer interface.

Because of the separate clocking line, there are no start, stop, formatting, or framing bits in use. The first nibble tells you which type of data you are about to receive. The choices include data being sent to the gauge, the data number (if an instrument can output multiple values), max, min, x-bar, sigma, max hold, min hold, or normal data. Most often, that nibble will be all ones for normal data output.

Nibbles two through four are used as 0-999 data-entry numbers. They are in the binary-coded-decimal (BCD) format with the most-significant bit (MSB) first.

A plain old micrometer might output only one data-entry number, while a fancier system can apparently deliver many different measurements on its sequential bit streams.

Nibble five is the sign bit with its MSB low for positive and high for negative.

Nibbles six through 11 should be the BCD numeric data with nibble six being the most-significant digit (MSD).

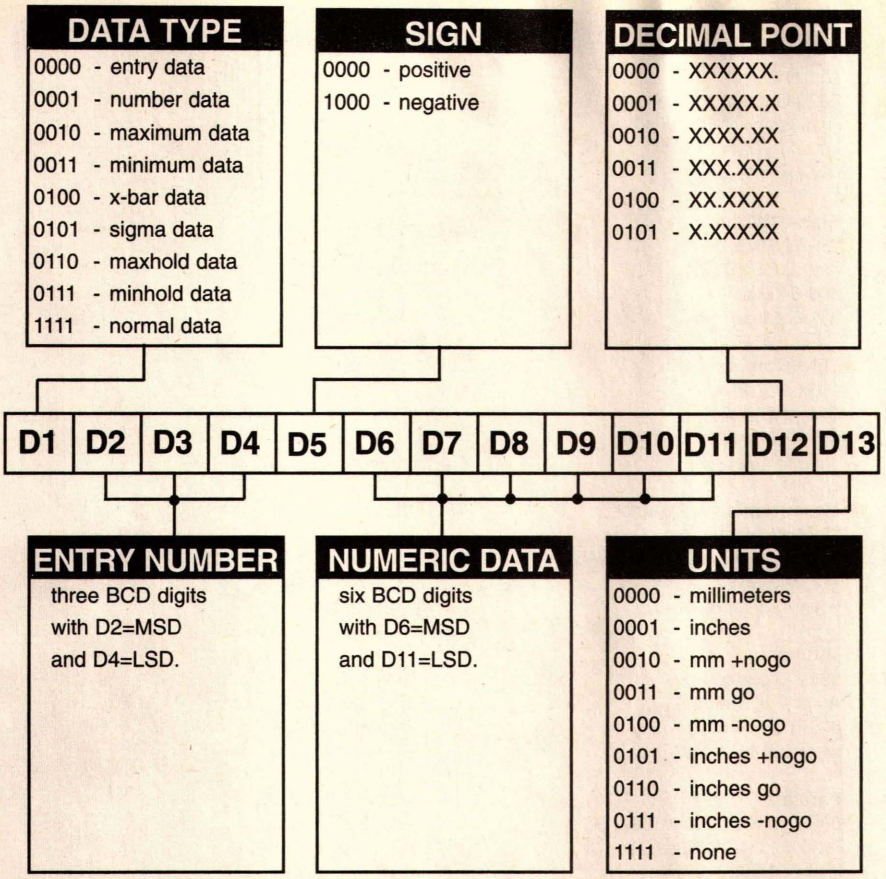

Fig. 3. The Digimatic data format consists of 13 four-bit "nibbles" that pass one measurement from gauge to host.

Byte twelve sets the decimal point for you with zero as an integer and five giving you five digits to the right of the decimal point. Thus, the interface can deliver six-decade accuracy over the plus-or-minus 9.99999- to 99999-range interval.

Nibble thirteen tells you the measurement units in use, with zero being millimeters and one being inches. Other options here are metric or inch, go or no-go, high or low, or "none of the above".

Be sure to have the actual spec on hand when developing any serious applications.

A PIC-to-Digimatic Interface

The PIC seems an obvious choice to build your own low-cost Digimatic interface. A single-channel PIC-based Digimatic-to-RS232 interface that was submitted by Carl Huben Consulting is shown in Listing 2. The complete sourcecode is found at *www.tinaja.com/picup01.html* as file DIGI232.ASM.

The "A" side of the PIC interfaces with your host computer's serial port, accepting simple control commands and returning your choice of the raw BCD or formatted data. The "B" side of the PIC does the needed Digimatic handshaking and uses the incoming clock and data signals to extract the needed info. A Visual Basic or similar program could interact with your interface.

The ASCII serial commands include F for data FORMAT, M for MODE, R for your RETURN data, and P to set your PERIODIC data interval.

Some PIC Books

Speaking of PICs, I have updated our recommended PIC books listing. This appears as our resource sidebar for this month. Also included are a few Parallax Basic Stamp titles and two new books on the alternate Atmel AVR microcontroller. Further details on all of these titles can be gotten at *www. tinaja.com/amlink01.html*. I've also done a major update and overhaul of our PIC links page found at *www.tinaja.com/pic500.html*.

Four-Point Curve Fitting

One better way to create smooth curves for animation, typography, or machine-tool paths involves strange math beasties called *cubic splines*. A *Bezier* curve is one version of cubic spline that is very popular.

We saw a tutorial on that back in my

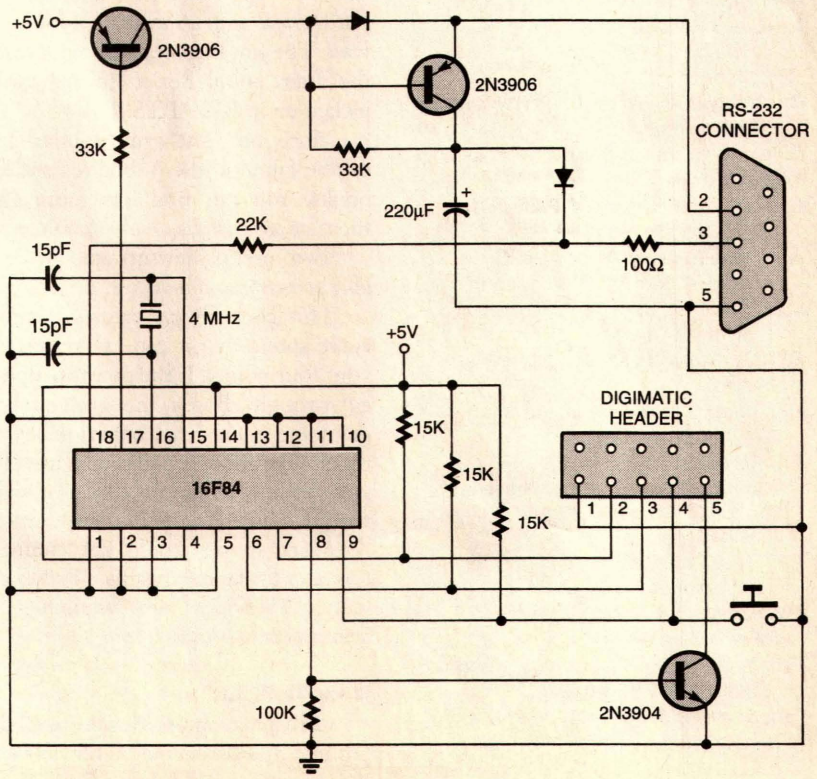

Fig. 4. A PIC-based Digimatic interface.

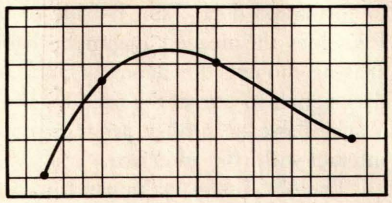

Fig. 5. The Postscript code given in Listing 1 draws a Bezier cubic-spline curve through four selected data points; here is an example of that program's output.

old "Hardware Hacker" column that appeared in the April 1993 issue of **Electronics Now**. If you don't have that issue handy in your stash of all-important stuff, I have it archived on my Web site as *HACK62.pdf*. More of the gory insider secrets on Bezier curves than you could possibly ever want to know are at *www.tinaja.com/cubic01.html*.

The PostScript computer language is especially adept when creating and using cubic splines. Listing 1 has example code that lets you fit a cubic spline to four on-the-curve points.

As usual, you bring the code up in an editor, change your data values, and then send it to Acrobat Distiller or GhostScript. More PostScript-as-language info can be found in *www.tinaja.com/post01.html* and *www.tinaja.com/acrob01.html*. The Jim Fitzsimmons math behind the four point Bezier fitting can be picked up in BEZ4PTS.PDF.

More on PostScript fundamentals can be found in the Adobe red and blue books. You can find lots more about those at *www.tinaja.com/amlink01.html*.

Two useful newsgroups are *comp.lang.postscript* and *comp.text.pdf*

This code always creates the finest cubic spline that it can exactly through your four points. If the points happen to get wrongly chosen, though, you might get some unexpected behavior between them. One cubic spline can be used for a straight line; a smooth curve; or shapes with one inflection point, cusp, or loop.

More splines could get connected together for fancier results. Further consulting services are available per *www.tinaja.com/info01.html*.

New Tech Lit

Carbon nanotubes are starting to show promise as a dense and highly cost-effective way to store hydrogen. Catch the latest advance in *Hydrogen Storage in Single-Walled Carbon Nanotubes at Room Temperature* by C. Liu and others in *Science*, November 5, 1999, pages 1127-1129.

Five percent storage by weight is reported. Reprints are available for $5 from *www.sciencemag.org*. More on hydrogen in general can be found at my *www.tinaja.com/h2gas01.html* or at *sci.energy.hydrogen*.

As I strongly suspected back in the "Tech Musings" column in January, there was a secret and utterly inexcusable defect in existing recordable CD-R technology—a flaw that makes it trivially easy to trash disks. It is called the "burn buffer underrun" problem. I sure have been burned by it.

The problem and its solution are detailed in *E.E. Times* for Nov 22, 1999 on page 41. Basically, when an open buffer underflows because of another program's activity, your disk gets trashed. A still-open disk might also get turned into a beer-stein coaster during routine reboots if it gets interrogated by anti-virus code. New Sanyo chips that might resolve that issue should be available shortly.

The real secret insider stuff on old

NAMES AND NUMBERS

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2325 Orchard Pkwy.
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408-441-0311
www.atmel.com

Stan Griffiths
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503-649-0837
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Cray, NC 27511
919-469-2500
www.mrfluid.com

Measurement & Control
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www.mac-med.com

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Rocklin, CA 95765
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Boxborough, MA 01719
978-263-1400
www.setra.com

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Thatcher, AZ 85552
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Zagros Robotics
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St. Louis, MO 63146
314-768-1328
www.zagrosrobotics.com

PIC AND BASIC STAMP BOOKS

AVR RISC Microcontroller Handbook (Claus Kuhnel)
Basic Stamp (Claus Kuhnel and Klaus Zahnert)
Basic Stamp II - Tutorial and Applications (Peter Anderson)
Design With PIC Microcontrollers (John Peatman)
Easy PIC'n, A Beginners Guide to the PIC (Dave Benson)
Intermediate Guide to Using PIC Microcontrollers (Dave Benson)
Microcontroller Beginner's Handbook (Lawrence Duarte)
PIC Microcontroller Applications (Harvey Weinberg)
PIC Microcontroller Handbook (Harvey Weinberg)
PIC Microcontroller Serial Communications (Roger Stevens)
PIC'n up the Pace PIC 16/17 Applications (Dave Benson)
PIC: Your Personal Introductory Course (John Morton)
Programming & Customizing the PIC Micro (M. Predko)
Programming & Customizing the Basic Stamp (Scott Edwards)
Programming & Customizing the AVR Microcontroller (D. Gadre)

For more book details, see *www.tinaja.com/amlink01.html*.

Listing 1

```
%!
% BEZIER CURVE THROUGH FOUR POINTS
% ================================
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% All commercial rights and all electronic media rights fully reserved.
% Personal use permitted provided header and entire file remains intact.
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% This utility demo shows how to use PostScript to draw a smooth Bezier
% curve through four points. It is based on the Jim Fitzsimmons tutorial
% and derivation in BEZ4PTS.PS
% /bez4pts is a modified Jim Fitzsimmons utility. This version draws
% a straight line from the currentpoint, then appends a Bezier curve
% through the next four points, presented as an eight element matrix.
% Data format is [ix0 iy0 ix1 iy1 ix2 iy2 ix3 iy3 ] bez4pts
/bez4pts {aload pop % unpack array
/y3 exch store /x3 exch store % stash data. Strange
/y5 exch store /x5 exch store % numbering is in use
/y4 exch store /x4 exch store
/y0 exch store /x0 exch store
/x1 x0 dup add x3 add 3 div def % solve for x1
/x2 x3 dup add x0 add 3 div def % solve for x2
/u4 x4 dup add x0 sub x3 sub x3 x0 sub div def % solve for u4
/u5 x5 dup add x0 sub x3 sub x3 x0 sub div def % solve for u5
/u0 -1 def /u3 1 def % define u0 and u3
/y04 y0 y4 sub u0 u4 sub div def % define y04
/y45 y4 y5 sub u4 u5 sub div def % define y45
/y53 y5 y3 sub u5 u3 sub div def % define y53
/y05 y04 y45 sub u0 u5 sub div def % define y05
/y43 y45 y53 sub u4 u3 sub div def % define y43
/b3 y43 y05 sub 2 div def % solve for b3
/b2 y05 u4 u5 add 1 sub b3 mul sub def % solve for b2
% Solve for y1.
/y1 y0 dup add y3 add b2 b3 sub dup add dup add sub 3 div def
% Solve for y2.
/y2 y3 dup add y0 add b2 b3 add dup add dup add sub 3 div def
x0 y0 lineto x1 y1 x2 y2 x3 y3 curveto % draw the cubic
} def
%% 100 300 moveto % demo - comment before use
%% [100 100 200 120 300 190 400 300]
%% bez4pts 0.1 setlinewidth stroke showpage
```

Tektronix oscilloscopes is now up at *www.reprise.com*. Hosted by Bill Den Beste and Stan Griffiths, the site supplies Tektronix vacuum tube, transistor and CRT cross references, probe data, a repair forum, and even classic Tektronix cartoons. Stan wrote *Oscilloscopes: Restoring a Classic*. More details at *www.tinaja.com/amlink01.html*.

I have got a very rare 6R1A "Nixie" digital-data plug-in tube and other Tektronix collectibles. You can e-mail me via *don@tinaja.com* for details.

From Setra, a freebie *Capacitance Pressure Transducer Handbook*. For other sources of similar info, check out the *Sensors* and the *Measurement and Control* trade journals. Bargain prices of capacitive accelerometers, mass flowmeters, and lots of similar laboratory goodies are picked up at *www.tinaja.com/bargsn01.html*.

A new access site for technical or scientific papers and abstracts can be found at *pubsci.osti.gov*.

The Nudist on the Late Shift is one highly readable collection of Silicon Valley stories and anecdotes. It is a book that appears to give a true flavor of what is actually coming down in this greed-driven and idealist-exploiting fantasy microcosm. The author is Po Bronson. Here at Synergetics, we don't often draw all that fine a distinction between our casual-dress days and the clothing-optional ones. I can not imagine anyone working very long or very hard for any employer that does. You will find more book details at *www.tinaja.com/amlink01.html*.

A directory of local building codes is found at *www.buildingteam.com* along with the names and numbers of those who enforce them.

Custom solutions to unique mobile, autonomous robotics projects can be found up at *www.zagrosrobotics.com*. They also have great buys on unusual robotic-sensor components. One magazine here is *Robot Science & Technology*.

A free "gee-whiz" demo on their *Rheonetic Magnetic Fluids* is offered by Lord. Magnetic fluids behave like a medium viscosity grease when they are unmagnetized but freeze up in the presence of a strong magnetic field. Obvious uses include speaker airgap eliminators or robotic clutches. This unique demo consists of two back-to-back plastic syringes. Thumb pressure easily moves the fluid until it gets locked up by a nearby magnet. This demo is also a "magic trick" and an instant Science Fair project.

For all the fundamentals of active filters, check into my *Active Filter Cookbook*. This is by far the best-selling book on active filters of all time. You can find more information in my nearby *Synergetics* ad or on my Web site. To get instant custom-research solutions, please be sure to visit *www.tinaja. com/info01.html*.

Our latest Web site additions up at *www.tinaja.com* include new sensor and lab-equipment pages, along with three newly-uploaded archives of the full "Hardware Hacker" column series at *www.tinaja.com/hack01.html*. Be sure to check our live e-Bay auctions by clicking on my AUCTION button.

Visit *www.tinaja.com/advt01.html* if you want to join the other industry leaders who are superb "Guru's Lair" sponsors. You click on the homepage STATS button for the latest info.

As usual, most of our referenced items are in the Names & Numbers or PIC Books sidebars. These have all been hotlinked in the online version of this column, MUSE145.PDF, which can be found at *www.tinaja.com/muse01.html*. Always be sure to check those links before calling our no-charge US tech helpline that you will find in the nearby assistance box.

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Non-Mechanical Switch Circuits

Touch-activated circuits are very popular and come in many different forms. Some operate by bridging a resistance across two contacts, while other circuits are triggered by capacitively loading a sensitive circuit. Light blocking is another method by which a circuit can be activated without actually making physical contact. There are many other sensing methods that can be used as touch sensors; for now, those three methods will just about fill our allotted space.

Resistance-Bridge Touch Switch

Our first touch-activated circuit, see Fig. 1, is of the resistance-bridging type using an LM339 quad comparator. Before we get into the circuitry, here's a little information on the LM339. Housed in a 14-pin DIP (dual-inline package), the LM339 contains four independent voltage comparators that are designed to operate from a single-voltage power source of 2 to 32 volts DC. The IC's idle current with all of the outputs turned off is less than 1 mA. Its input voltage can range from zero to the supply rail, and its output is compatible with TTL, MOS, and CMOS logic. The LM339 can withstand a direct output short to ground and safely dissipate over 500 mW.

The LM339 comparator's operation is similar to that of a generic op-amp without a gain-setting feedback resistor. When the comparator's positive input (pin 5) increases or decreases, the IC's output moves in the same direction (*i.e.*, as the input voltage goes up, the output signal level goes up and *vice versa*). However, when the negative input (pin 4) moves in one direction, the output goes in the opposite direction. The positive (+) input is the non-inverting input, and the negative (−) input is the inverting input.

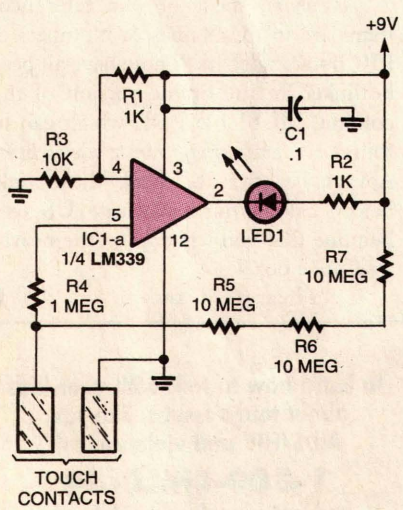


Fig. 1. The Resistance-Bridge Touch Switch is built around a single section of an LM339 quad comparator. The circuit is designed so that its output is forced low whenever someone bridges its touch contacts.

PARTS LIST FOR THE RESISTANCE-BRIDGE TOUCH SWITCH (FIG. 1)

SEMICONDUCTORS
IC1—LM339 quad comparator, integrated circuit
LED1—Light-emitting diode, any color

RESISTORS
(All resistors are 1/4-watt, 5% units.)
R1, R2—1000-ohm
R3—10,00-ohm
R4—1-megohm
R5–R7—10-megohm

ADDITIONAL PARTS AND MATERIALS
C1—0.1-µF, ceramic-disc capacitor
Printed-circuit board or perfboard materials, IC socket, metal touch-contacts, wire, solder, hardware, *etc.*

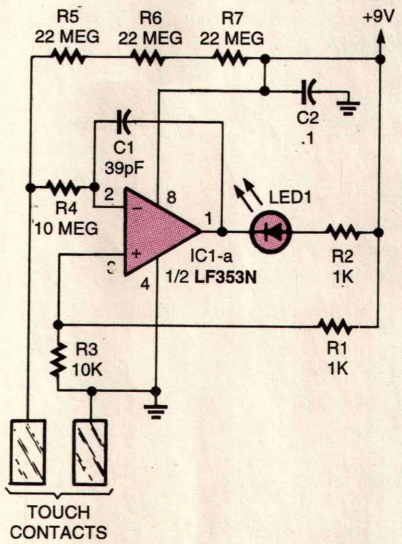


Fig. 2. This Resistance-Bridge Touch Switch, although slightly different from the previous one—built around half of an LF353N dual JFET op-amp with a one-touch contact connected to each op-amp input—performs in an almost identical manner.

PARTS LIST FOR ANOTHER RESISTANCE-BRIDGE TOUCH SWITCH (FIG. 2)

SEMICONDUCTORS
IC1—LF353N dual JFET op-amp, integrated circuit
LED1—Light-emitting diode, any color

RESISTORS
(All resistors are 1/4-watt, 5% units.)
R1, R2—1000-ohm
R3—10,000-ohm
R4—10-megohm
R5–R7—22-megohm

CAPACITORS
C1—39-pF, ceramic-disc
C2—0.1-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS
Printed-circuit board or perfboard materials, IC socket, metal touch-contacts, wire, solder, hardware, *etc.*

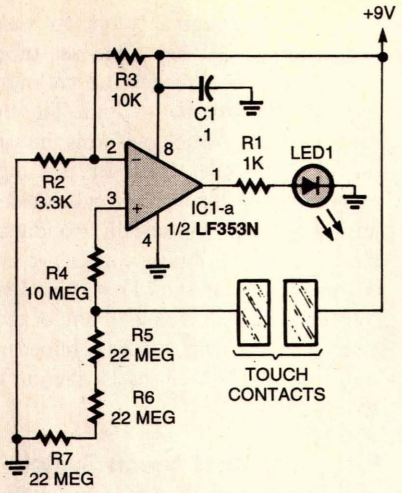


Fig. 3. The output of the op-amp used in the Touch-To-Operate Switch is normally low. But when the touch contacts are bridged, the output of the op-amp toggles high, causing the LED to light.

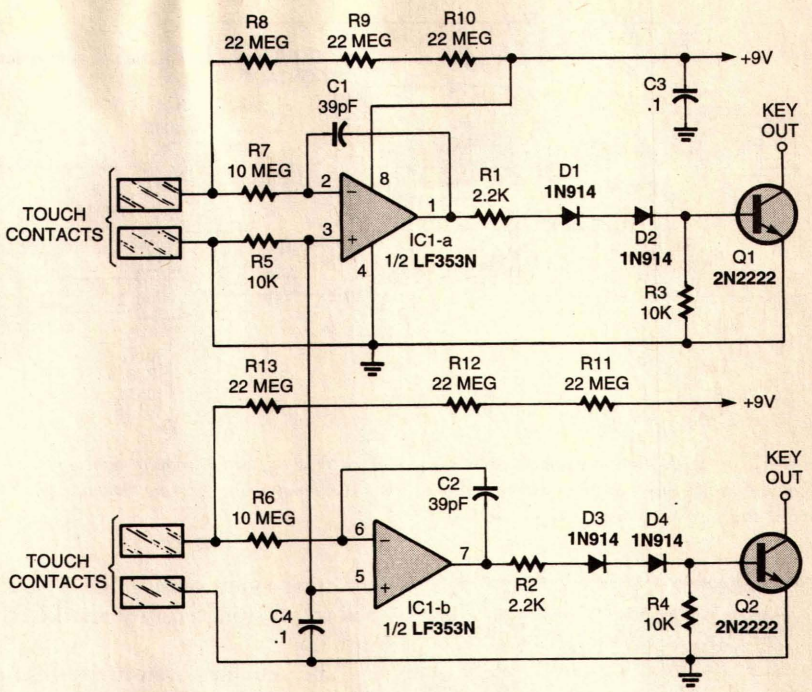


Fig. 4. The Touch-Operated CW keyer is designed for use in amateur-radio applications. One set of the switch contacts activates the dit output and the other the dah output.

PARTS LIST FOR THE TOUCH-TO-OPERATE SWITCH (FIG. 3)

SEMICONDUCTORS
IC1—LF353N dual JFET op amp, integrated circuit
LED1—Light-emitting diode, any color

RESISTORS
(All resistors are 1/4-watt, 5% units.)
R1—1000-ohm
R2—3300-ohm
R3—10,000-ohm
R4—10-megohm
R5–R7—22-megohm

ADDITIONAL PARTS AND MATERIALS
C1—0.1-μF, ceramic disc capacitor.
Printed-circuit board or perfboard materials, IC socket, metal touch-contacts, wire, solder, hardware, *etc.*

In Fig. 1, the inverting input (pin 4) of the comparator is biased to about 8 volts through a voltage-divider network comprised of R1 and R3. The non-inverting input (pin 5) of IC1-a is connected to the positive supply through three 10-megohm resistors. The voltage at the comparator's non-inverting input is slightly greater than that at the inverting input, so the comparator's output swings positive. Since the comparator's output circuitry is an open-collector NPN transistor, no current flows through LED1, so it remains off. Bridging the touch contacts with a resistive material, say a human digit (finger), lowers the voltage applied to the non-inverting input to a value less than that of the inverting input—causing the comparator's output to go low and lighting LED1. The bridging resistance necessary to activate the touch circuit can be just about any value below 100 megohms.

Another Resistance-Bridge Touch Switch

Our next touch-activated circuit, shown in Fig. 2, replaces the comparator with an LF353N dual JFET op-amp, which offers high-input impedance (about 1,000,000,000,000 ohms). The op-amp's non-inverting input is set to about 8 volts through a resistor string comprised of R1 and R3. The inverting input of IC1-a is connected to the positive supply through one 10-meghom and three 22-megohm resistors. That sets the voltage at the inverting input higher than that applied to the non-inverting input, causing the op-amp to conduct and light LED1. Bridging the touch contacts drops the voltage at the inverting input to less than 8 volts, which turns the op-amp and LED off. The 39-pF capacitor (C1) that's connected between the inverting input and output furnishes a negative feedback path to help reduce interference from stray AC signals. The best way to keep unwanted AC signals from interfering with the circuit's operation is to always touch the ground contact first.

PARTS LIST FOR THE TOUCH-ACTIVATED CW KEYER (FIG. 4)

SEMICONDUCTORS
IC1—LF353N dual JFET op-amp, integrated circuit
Q1, Q2—2N2222 general-purpose NPN silicon transistor
D1–D4—1N914 general-purpose, small-signal, silicon diode

RESISTORS
(All resistors are 1/4-watt, 5% units.)
R1, R2—2200-ohm
R3–R5—10,000-ohm
R6, R7—10-megohm
R8–R13—22-megohm

CAPACITORS
C1, C2—39-pF, ceramic-disc
C3, C4—0.1-μF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS
Printed-circuit board or perfboard materials, IC socket, metal touch-contacts, wire, solder, hardware, *etc.*

Touch-To-Operate Switch

A touch-to-operate version of the high-input impedance op-amp circuit is offered in Fig. 3. The inverting input is

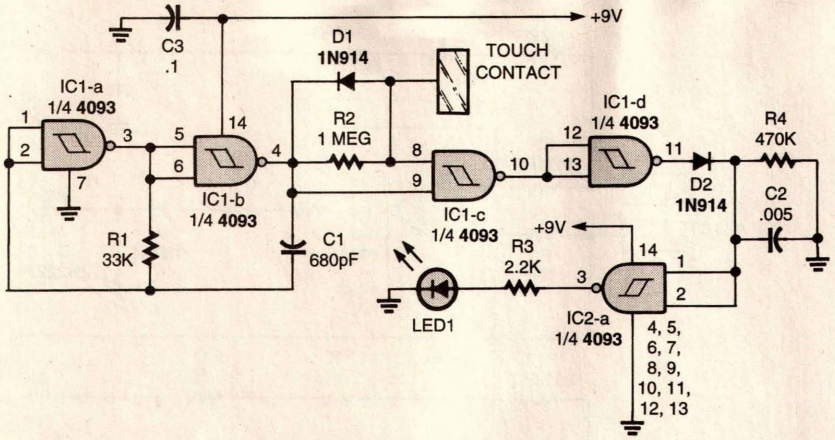


Fig. 5. Unlike the non-mechanical switches discussed thus far, which require dual contacts, the Single-Contact Touch Switch presented here uses an AC-signal-source sensing technique that eliminates the need to bridge a pair of contacts.

PARTS LIST FOR THE SINGLE-CONTACT TOUCH SWITCH (FIG. 5)

SEMICONDUCTORS

IC1, IC2—4093 CMOS quad two-input NAND Schmitt trigger, integrated circuit
D1, D2—1N914 general-purpose, small-signal, silicon diode
LED1—Light-emitting diode, any color

RESISTORS

(All resistors are 1/4-watt, 5% units.)
R1—33,000-ohm
R2—1-megohm
R3—2200-ohm
R4—470,000-ohm

CAPACITORS

C1—680-pF, ceramic-disc
C2—0.005-μF, ceramic-disc
C3—0.1-μF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

Printed-circuit board or perfboard materials, IC socket, metal touch-contacts, wire, solder, hardware, *etc.*

set to about 2.2 volts via a resistor network comprised of R2 and R3, while the non-inverting input is grounded through one 10-megohm and three 22-megohm resistors. The voltage appearing at IC1-a's non-inverting input is lower than that applied to its inverting input, keeping the op-amp and LED turned off. The touch contacts of this circuit *do not* take the input to ground, as in the previous circuits, but to the positive supply rail. When the touch contacts are bridged, the non-inverting input goes positive with respect to the inverting input, causing IC1-a's output voltage to swing positive and LED1 to turn on.

The circuit's sensitivity can be increased or decreased by adding or removing one or more of the 22-megohm resistors used in the input string. Adding resistors increases the circuit's sensitivity and removing resistors lowers it. The upper sensitivity limit available depends on the amount of AC and RF signals that are present at the touch contacts. One method of reducing the effects of stray signals is to surround the high-impedance touch contact with the low-impedance touch contact; e.g., encircling one within the other, like a donut.

Touch-Operated CW Keyer

The next touch-activated circuit, refer to Fig. 4, uses both LF353N op-amps in a CW keyer designed for use in amateur-radio applications. The majority of transceivers marketed today have a built-in electronic continuous-wave (CW) generator, which is designed to operate with a dual-contact CW key. One set of the switch contacts activates the *dit* output and the other the *dah* output. The dual touch-activated switch performs the same job electronically. Each of the high-impedance touch contacts can be made of just about any electrically conductive material, such as brass, copper, or even circuit-board material. The ground-side contact can also be made of any of those materials. Of course, the high-impedance contacts must be well insulated from the ground circuit.

Single-Contact Touch Switch

Our first four circuits were based on a DC-bridging technique that required a resistive path between two conductors to activate the sensing circuit and produce an output. In our next two circuits, the sensing technique uses an AC signal source, thereby eliminating the need to bridge a pair of contacts.

The first single-touch contact circuit is shown in Fig. 5. In that circuit, two gates of a 4093 CMOS quad two-input NAND Schmitt trigger are used as the active device. The two gates, IC1-a and IC1-b, along with R1 and C1 make up a simple astable oscillator with an operating frequency of 35 kHz. The output of the oscillator is fed to the inputs of IC1-c. One gate input is direct coupled to the oscillator's output, while the other input is connected to the oscillator output through a 1-megohm resistor that's connected in parallel with a 1N914 small-signal silicon diode. Without anything touching the touch contact, IC1-c inverts the output of the oscillator and feeds the resulting signal to IC1-d. That gate once again inverts the signal and feeds it to D1. Diode D1 (configured as a positive half-wave rectifier) produces a

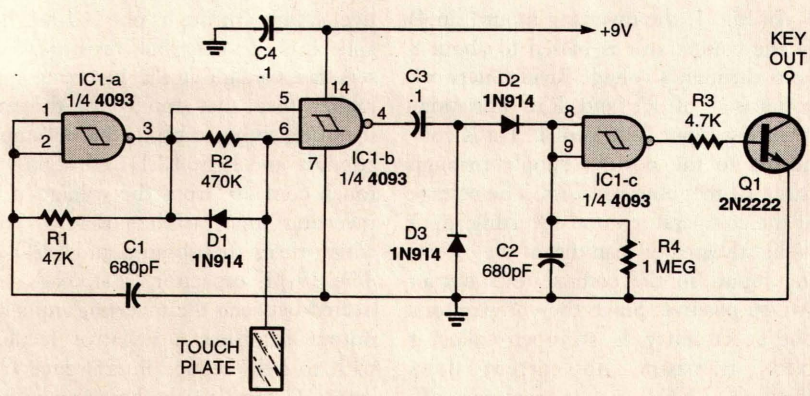


Fig. 6. Like the circuit in Fig. 5, this Single-Contact Touch Switch does not require contact bridging, but it performs its duties using fewer components.

PARTS LIST FOR THE SIMPLER SINGLE-CONTACT TOUCH SWITCH (FIG. 6)

SEMICONDUCTORS

IC1—4093 CMOS, quad two-input NAND Schmitt trigger, integrated circuit
Q1—2N2222 general-purpose NPN silicon transistor
D1–D3—1N914 general-purpose, small-signal, silicon diode

RESISTORS

(All resistors are 1/4-watt, 5% units.)
R1—47,000-ohm
R2—470,000-ohm
R3—4700-ohm
R4—1-megohm

CAPACITORS

C1, C2—680-pF, ceramic-disc
C3, C4—0.1-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

Printed-circuit board or perfboard materials, IC socket, metal touch-contacts, wire, solder, hardware, *etc.*

PARTS LIST FOR THE LIGHT-ACTIVATED SWITCH (FIG. 7)

SEMICONDUCTORS

IC1—4093 CMOS, quad two-input NAND Schmitt trigger, integrated circuit
Q1—IR phototransistor (RadioShack 276-145 or similar)
Q2—2N2222 general-purpose NPN silicon transistor
LED1—Infrared light-emitting diode (RadioShack 276-143 or similar)

RESISTORS

(All resistors are 1/4-watt, 5% units.)
R1—1000-ohm
R2—100,000-ohm
R3—10,000-ohm

ADDITIONAL PARTS AND MATERIALS

C1—0.1-µF, ceramic-disc capacitor
Printed-circuit board or perfboard materials, IC socket, metal touch-contacts, wire, solder, hardware, *etc.*

positive DC bias that is applied to both inputs of IC2-a. As long as the positive bias is present, IC2-a's output remains low, so LED1 does not glow. Touching the contact drains off the positive-going portion of the 35-kHz signal, preventing the output of IC1-c from going low and IC1-d's output from going high. The positive voltage across C2 is discharged by R4, allowing the inputs of IC2-a to go low, which forces its output high, turning on LED1.

Simpler Single-Contact Touch Switch

Our second AC touch circuit, see Fig. 6, is very similar to the last one, but is somewhat simpler in design: it uses only three gates of a single 4093. The first gate, IC1-a, is configured as a simple astable oscillator, which operates at about 45 kHz. As was done in the previous circuit, the output of the oscillator is fed to both inputs of IC1-b, whose output is then applied through C3 to a dual-diode rectifier circuit, comprised of D2 and D3. The rectified output of the dual-diode circuit is applied to both inputs of IC1-c. In normal operation, the DC voltage at the cathode of D2 is close to 9 volts. That causes IC1-c's output to go low. Touching the contact reduces the AC signal applied to pin 6 of IC1-b, which stops the AC output at pin 4. The DC voltage across C2 is discharged through R4, as IC1-c's output goes high, turning on Q1. Transistor Q1's open collector can be used to switch a positive load to ground or to key a positive line to ground.

Light-Activated Switch

Our last touch-activated circuit, shown in Fig. 7, uses light as the medium and actually doesn't require a touch to operate. An infrared LED is directed at an IR-sensitive phototransistor that is placed about two inches from the LED. The IR light source turns the phototransistor on, lowering its collector voltage to near ground potential. Gate IC1-a's output is high, while IC1-b output is low. The low output of IC1-c is applied to the base input of Q2, keeping it turned off. When an opaque object blocks the light path between the two IR devices, the phototransistor's output goes high reversing the outputs of IC1-a and IC1-b, causing Q2 to turn on.

Here's hoping that at least one of the touch-activated circuits that we've looked at this visit will be useful in an ongoing project or may be in a future one. In any case, let me hear from you about these circuits and those that you'd like to see here in the future. Contact me via e-mail at *cdrakes@ipa.net* or by snail mail at Charles D. Rakes, P.O. Box 445, Bentonville, AR 72712. P

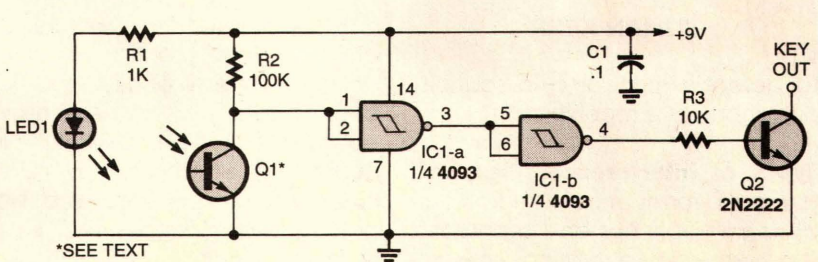
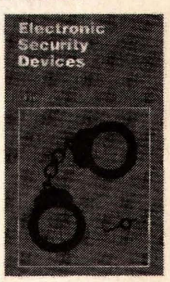


Fig. 7. This non-mechanical switch, instead of relying on personal contact with its operator, uses light (or the absence thereof) to trigger a response.

ELECTRONIC SECURITY DEVICES



A great book for project builders. It is quite common to associate the term "Security Devices" with burglar alarms of various types. However in fact it can refer to any piece of equipment that helps to protect people or property. The text is divided into three basic sections: Chapter 1 covers switch-activated burglar alarms and includes exit and entry delays. Chapter 2 discusses other types of burglar alarms and includes Infra-Red, Ultrasonic and Doppler-Shift Systems. Chapter 3 covers other types of security devices such as Smoke and Gas Detectors; Water, Temperature and Baby Alarms; Doorphones, etc. Most circuits are simple, and stripboard layouts are provided.

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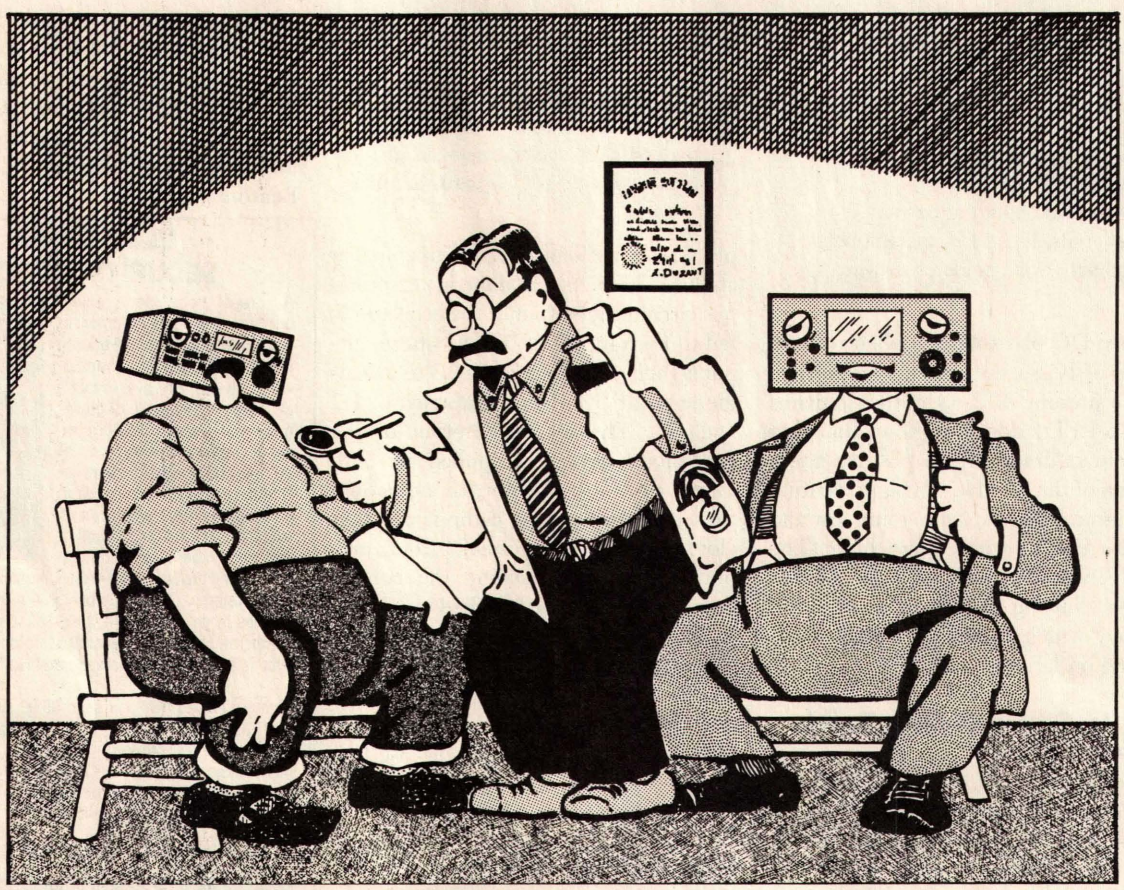
Curing Scanner and Shortwave Receiver Overload Problems

Modern communications equipment can do wondrous things; unfortunately those same highly sophisticated devices can cause a multitude of communications interference nightmares. In this article, we'll explore some of the problems encountered by radio buffs and look at how those ailments can be eliminated.



JULIAN KERR

Radio receivers often must contend with overload interference. That's a fact of life. While high-priced, high-quality receivers can handle overload conditions better than inexpensive units, the real issue is, What are the sources of overload problems and how can their affects be blunted?

In this article, we'll explore some of the methods that can be used to defeat overloading in scanner and shortwave receivers.

Types of Interference. There are four basic forms of overload associated with scanner and shortwave receivers—*desensitization, unwanted harmonics generation, distortion,* and *intermodulation*—which can be further classified as *co-channel interference, adjacent channel interference,* and *off-channel interference.* We'll discuss each of them, but keep in mind that actual situations may involve two or more combinations of both groups and therefore will require multiple solutions.

Co-Channel Interference involves unwanted signals sharing the same

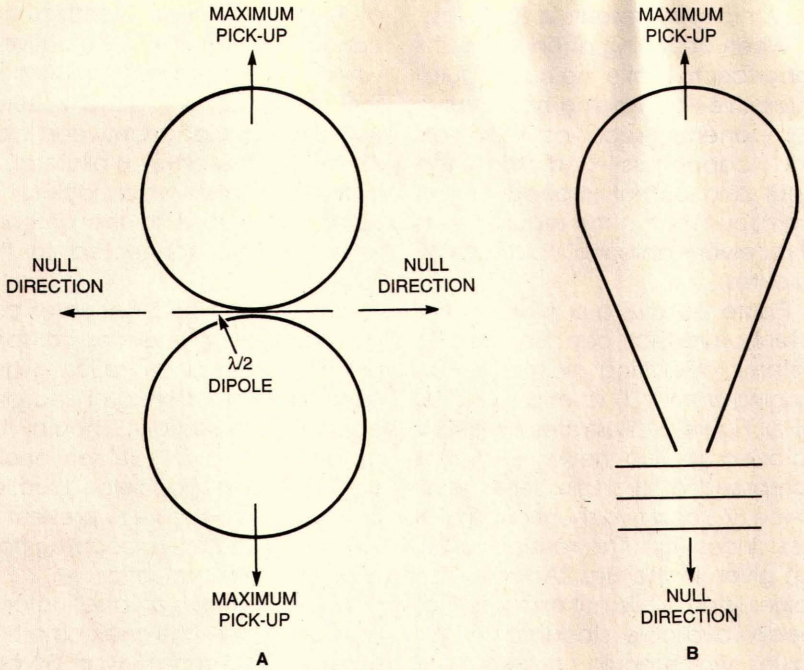


Fig. 1. A dipole has two nulls that are located off the ends of the radiator element (as shown in A) and oriented perpendicular to the directions of maximum pick-up. Yagi and quad antennas, on the other hand, have nulls in a direction opposite to that of maximum pick-up (as shown in B).

channel as the desired transmission. Unfortunately, there is little that can be done to remedy that situation short of using a directional antenna—an antenna that favors the desired station, while rejecting unwanted signals. Directional antennas have *null direction;* defined as the direction of minimum (least) pick-up.

For example, dipole antennas have two nulls (as shown in Fig. 1A) that are located off the ends of the radiator element and are perpendicular to the directions of maximum pick-up. On the other hand, other antenna configurations (Yagis or quads, for example) have nulls in a direction opposite to that of maximum pick-up (see Fig. 1B). In order to overcome co-channel interference, the null of the antenna should be aimed in the direction of the interfering signal.

The null directions of beam and dipole antennas are relatively easy to locate. Unfortunately, many hobbyists use either random-length or long-wire antennas, which have multiple nulls. Multiple nulls are functions of both frequency and physical length, so predicting the null direction of random-length or long-wire antennas is difficult at best.

Scanner and FM broadcast-band listeners often use omnidirectional or multidirectional antennas in the VHF/UHF regions, so co-channel interference is particularly difficult to cure. For those operators, a change of antenna might be in order if receiving a particular station is important.

Adjacent Channel Interference is caused by stations operating on channels that are close to the frequency being received. Wavetraps (a form of filter) can alleviate interference problems; but, in other instances, a receiver that has excellent dynamic range and selectivity is the only solution.

Off-Channel or Out-of-Band Interference results when a strong local signal is transmitted on an unrelated frequency. Those signals can be curtailed through the use of wavetrap, passband, or bandstop filters. A wavetrap is a filter circuit that is designed to attenuate a particular frequency. A passband filter is a circuit that is designed to pass the desired frequency band, while attenuating all other frequencies. A bandstop filter attenuates the frequencies in the band of the offending signal, but not other frequencies.

Desensitization occurs when a strong local signal very heavily drives an RF amplifier or other front-end component, leaving little dynamic range for the desired signals, producing an effect not unlike reducing the receiver's RF gain. There are times when the interference appears and disappears, possibly indicating that the interfering transmitter is being turned on and off.

Autorectification, which produces a DC bias from the offending RF signal that reduces front-end gain much like an automatic-gain control, is a common cause of desensitization.

Harmonics Generation occurs when the output of a nonlinear circuit encroaches on an otherwise harmonic-free RF signal: For example, when a nearby AM station overloads the receiver's RF amplifier, driving it into nonlinear operation. Harmonics are integer multiples of the fundamental frequency (2*f*, 3*f*, 4*f*, 5*f*...), causing a particular AM station to appear at successively higher frequencies. For example, a station transmitting on 1500-kHz AM might produce harmonics at 3000 kHz, 4500 kHz, 6000 kHz, *etc.*

The problem is not caused by bad tuning or malfunctions at a transmitting radio station; it is instead a normal response to nonlinear conditions within your receiver. While it is rare for more than the first three or four harmonics to be produced, it is possible to generate spurious harmonics well into the low-VHF band.

Distortion results when a receiver's dynamic range is insufficient to handle strong local signals. In such situations, not only might the audio recovered from the signal be distorted, but there could also be some distorting of the RF signal, causing the generation of spurious signals.

Intermodulation, which is created in nonlinear RF front-end circuits, is caused by heterodyning two or more signals together. The new frequencies that can be generated are:

$$f_{NEW} = nf_1 \pm mf_2 \qquad (1)$$

where f_1 and f_2 are two different input frequencies, and n and m are integers. The number of possible combinations of n, m, f_1 and f_2 is immense

... and because of that, intermodulation is often extremely hard to solve without the aid of a high-priced spectrum analyzer. If, however, you can locate the two frequencies involved, one or both of them can be filtered out or attenuated.

Now that we've defined some of the problems associated with scanner and shortwave-receiver operation, let's explore some of the methods by which the offending signals can be eradicated.

Attenuators. An attenuator is a resistive circuit that provides a loss between input and output. The ratio of the loss is usually expressed in terms of decibels (dB) from the following equations:

$$dB = 20 \log_{10} (V_O/V_{in}) \quad (2)$$

and

$$dB = 10 \log_{10} (P_O/P_{in}) \quad (3)$$

For reference, a 2:1 voltage ratio represents a −6 dB loss, and a 2:1 power ratio represents a 23 dB loss.

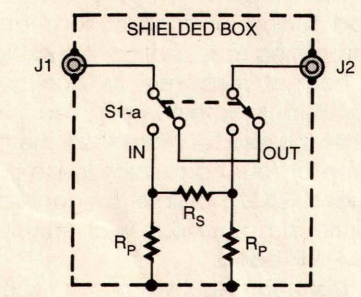
When designing attenuators, it's important to make the circuit purely resistive—containing no reactive components, such as inductors and capacitors—and that the input and output impedances of the circuit match the requirements of receiver's antenna input (usually 50 ohms).

Figure 2 shows a pair of 50-ohm attenuators that can be used in systems operating in the region ranging from VLF to mid-VHF (200 MHz). Figure 2A illustrates an attenuator—a pi- (π) network—that is comprised of a single series resistance (R_S) and two shunt or parallel resistances (R_P). The resistor values are given in the Fig. 2A table. The values listed, while not exact, reflect readily available standard resistor values, which could cause a slight impedance mismatch or perhaps a slightly different attenuation ratio.

The double-pole, double-throw (DPDT) switch can be used to bypass the attenuator network by placing S1 in the OUT position, thereby feeding the input directly to any connected receiver. Alternatively, when S1 is placed in the IN position, the attenuator is placed in series with the signal path between jacks J1 and J2. The circuit is bilateral, so it doesn't matter which jack (J1 or J2) is connected to the antenna and which is connected to the receiver.

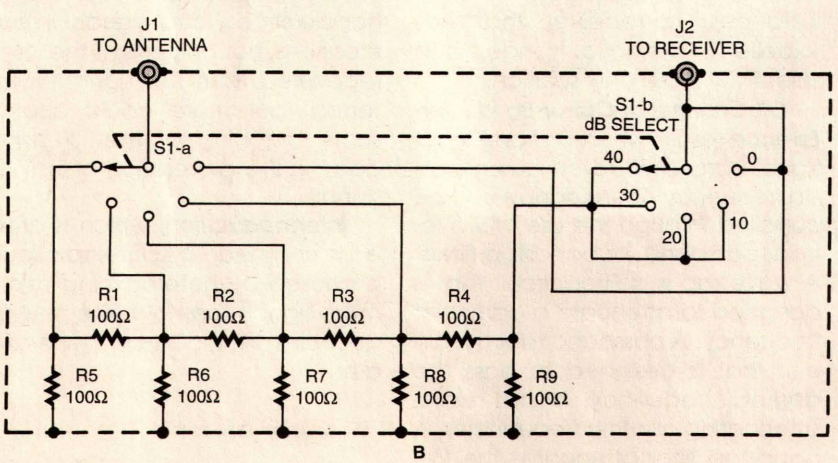
More than one attenuator can be connected in series to form greater attenuation ratios. When using multiple attenuator sections, each sub-assembly should be housed in its own shielded enclosure or at least in a shielded section of the main enclosure to prevent RF leakage or inductive coupling from altering the design ratio.

Figure 2B shows an attenuator of a different sort—this one comprised of several 100-ohm, 1/4-watt, 5% carbon-composition or metal-film resistors and S1 (a single-pole, five-position rotary switch, which provides selectable attenuation ratios of 0 dB, 10 dB, 20 dB, 30 dB, and 40 dB). Because the Fig. 2B attenuator is not bilateral, J1 must be connected to the antenna and J2 to the receiver's antenna input.



ATTEN. (dB)	R_S (Ω)	R_P (Ω)
3	18	330
6	33	150
12	91	82

A



B

Fig. 2. Shown here are two different attenuator networks that are designed for 50-ohm antenna systems. The circuit in A is a pi- (π) network attenuator, while the step attenuator shown in B uses a dual-ganged, 5-position rotary switch to allow the user to select from among several attenuation ratios: 0 dB, 10 dB, 20 dB, 30 dB, and 40 dB.

Wavetraps. Based on the respective properties of series- and parallel-resonant inductor/capacitor (LC) tank circuits, the wavetrap is a specially designed filter that can be configured to attenuate a single frequency or a narrow band of frequencies. Figure 3 shows a pair of wavetraps—a parallel-resonant tank circuit comprised of C1-a, C1-b, and L1 and a series resonant circuit composed of C2 and L2—housed in a single shielded enclosure. Either version can be used alone, or they can be combined to function as a single unit.

The parallel-resonant tank circuit offers a very high impedance to the resonant frequency, but a low impedance to frequencies removed from resonance. When a parallel-resonant tank circuit is placed in series with the signal path, maximum attenuation occurs at the resonant frequency (solid trace in Fig. 3B). The series resonant portion of the circuit, on the other hand, offers a very low impedance to its resonant frequency, so it attenuates the

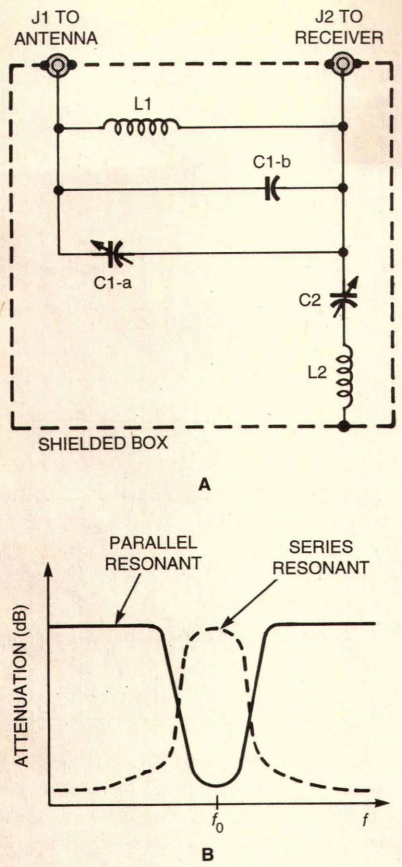


Fig. 3. The RF interference filter in A is comprised of a pair of wavetraps (one series and the other parallel) housed in a single shielded enclosure. A parallel resonant tank circuit placed in series with the signal path provides maximum attenuation at the resonant frequency (as shown by the solid curve in B), while a series resonant wavetrap provides a very low impedance to the signal at its resonant frequency (see dotted-line curve).

resonant frequency, but not the others (dashed-line trace in Fig. 3B).

Combining series- and parallel-resonant wavetraps maximizes the attenuation of a single frequency, assuming that both tank circuits are tuned to the same frequency. In some cases, there might be two interfering stations, which would necessitate two tank circuits—with one tank resonating at one frequency and the other resonating at the other frequency.

The component values used in the wavetrap depend on the frequency of the offending signal and can be determined from:

$$f = 1/2\pi\sqrt{(LC)} \qquad (4)$$

But, because we are more likely to know the frequency to be attenu-

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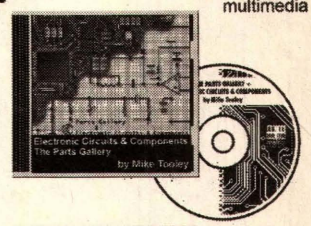

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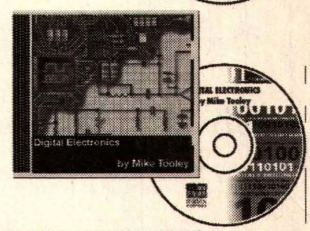

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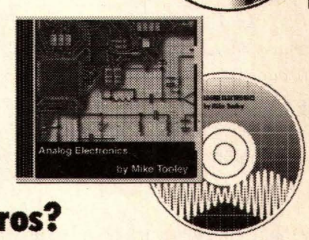

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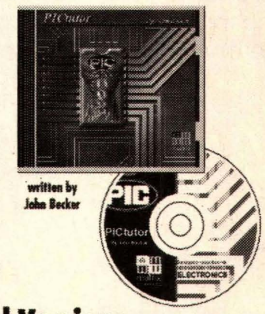

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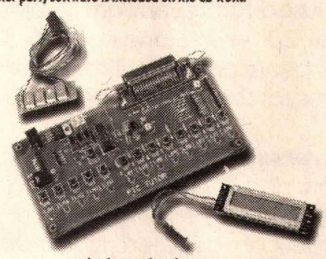
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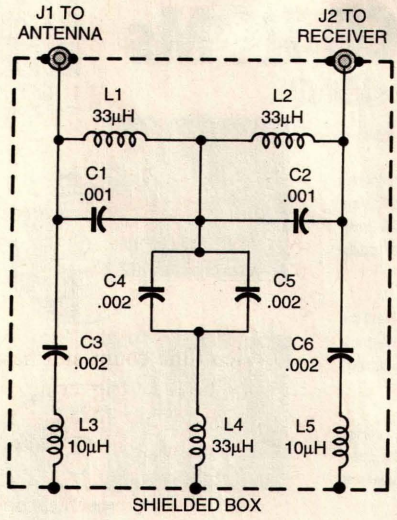

Fig. 4. A bandstop wavetrap—like the one shown here, which is designed for the AM broadcast band—attenuates all frequencies within an entire band and is especially useful when there are multiple stations in the band overloading shortwave or scanner receivers

ated and need to know the inductance or capacitance, the component values can be calculated from:

$$L = 1/39.5f^2C \qquad (5)$$

or

$$C = 1/39.5f^2L \qquad (6)$$

where *f* is frequency in hertz, L is inductance in henrys, and C is capacitance in farads. Actual component values will vary from the calculated values because of stray capacitances and component tolerances. At low frequencies, stray inductances are not usually a factor.

The actual capacitor value will be somewhat less than that specified because of stray capacitance; however, using a variable capacitor or inductor (or both) allows for error compensation.

Bandstop Wavetrap. The bandstop wavetrap, a variation of the previous filter, is designed to attenuate all frequencies within an entire band. They're used when multiple stations operating within the band overload a scanner or shortwave receiver. The AM broadcast band is ripe for wavetrap treatment because of the large number of high-power signals "roaming" the band in some metropolitan areas.

Figure 4 shows a bandstop filter designed for the AM broadcast band that can be assembled from readily available components. When assembling such a circuit, a quick little rule is to separate the coils a couple inches, and place L3, L4, and L5 at right angles to L1/L2.

High-Pass Filters. In the cases that we've dealt with so far, the offending signals are usually below the desired frequency. So, high-pass filters can be used to pass the desired frequencies, while attenuating unwanted signals. Scanner operators worried about AM, HF ham, and CB stations might consider using a low-VHF high-pass filter similar to the pair shown in Fig. 5.

The version shown in Fig. 5A is designed for receivers with 75-ohm coaxial inputs, while the circuit in Fig. 5B is designed for balanced 300-ohm twin-lead systems. In the latter case, 0.001-µF, 1000-volt ceramic- disc capacitors are sometimes used at the points marked "X." The capacitors are used for receivers that do not use a power transformer.

Both filter configurations are very similar to TV high-pass filters, which are used to prevent amateur radio and CB interference. Such filters are available from TV and video stores for 0.54 MHz.

Universal High-Pass Filter. A variation of the high-pass filter (a universal version) is shown in Fig. 6. That circuit can be used to attenuate the entire AM broadcast band when it interferes with a shortwave-receiver reception. The coil is actually a 10.7-MHz FM IF coil with a capacitor that was crushed in order to remove it.

The filter is designed to pass frequencies above 3000 kHz and attenuate those (such as the AM band) below that frequency. Capacitor and inductor values for other frequencies can be calculated from:

$$L = R/4\pi f_C \qquad (7)$$

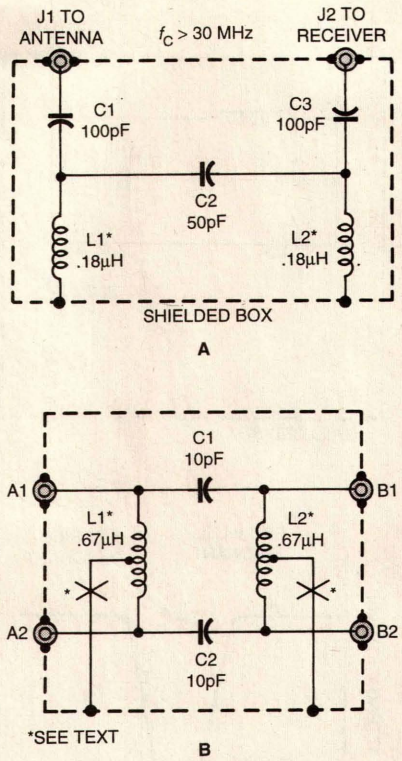

Fig. 5. The high-pass filter shown in A is designed for use with receivers that have coaxial antenna inputs with a 75-ohm impedance. The circuit in B is designed for balanced 300-ohm twin-lead systems. These filters are very similar to TV high-pass filters, which are used to prevent amateur radio and CB interference.

and

$$C = 2/4f_CR \qquad (8)$$

where L is inductance in henrys, C is capacitance in farads, f_C is the cutoff frequency in hertz (Hz), and R is the system impedance (either 50 or 75) in ohms.

Construction. Because the filters and attenuators are RF devices, they must be built into shielded enclosures. There are a number of such enclosures on the market that are especially designed for RF enthusiasts. The best enclosure for RF projects are die-cast boxes that form a good RF seal. Unfortunately, that type of box is not readily available in many localities.

However, aluminum sheet-metal boxes, which are a viable alternative, are generally available in two basic styles—"butt-fit" and "overlapping flange." The butt-fit type, is held together by small dimples on

(Continued on page PR-3)

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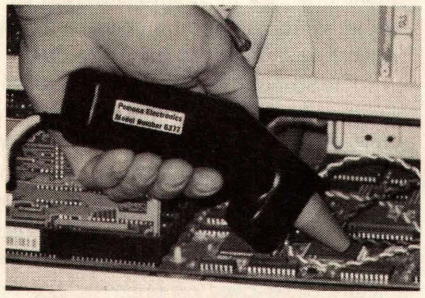

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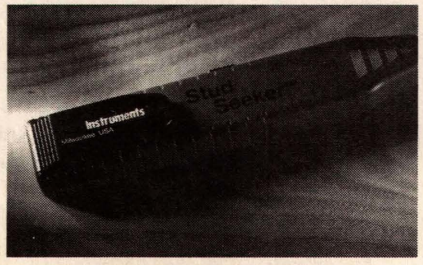

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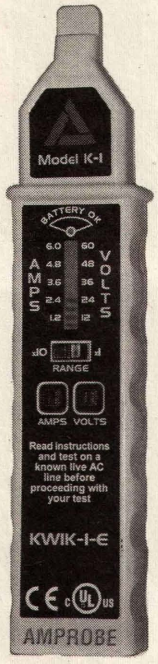

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ProService Review

March, 2000

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An official journal of NESDA (National Electronics Service Dealers Association), and ISCET (International Society of Certified Electronics Technicians).

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PURPOSE

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With the exception of official announcements, the statements and opinions expressed herein are those of the authors and not necessarily those of the associations.

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BUSINESS/EDITORIAL OFFICES

2708 W. Berry St., Ft. Worth, TX 76109-2397
817-921-9061; Fax 817.921.3741
www.nesda.com
Executive Director: Clyde W. Nabors
Editor-in-Chief: Wallace S. Harrison
Email: Wallace.H@nesda.com
Associate Editor/Production: M. Merrill
Email: Mary.Margaret@nesda.com

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Contents

ISCET Certification 3
NESDAnet 4
NESDA Long Distance Plan 5
Deming Management at Work 5
NESDA Membership 6
NPSC 2000 Registration 8

ARTICLES

Getting the Right People to Run Your Counter and Your Phones
by Fred Longworth 1

Telephone Tips 2

Your Working Environment
by Nancy Buchanan 3

Thoughts on Empowerment
by Rick Maurer 4

Coping with Difficult Employees
by Kenny Jenkins 6

Getting the Right People to Run Your Counter and Your Phones

Most service centers try to economize where they can to keep costs down and profits up. However, cutting costs in customer service may be fooling you with false economy. You may be surprised what *your* reps are saying.

by Fred Longworth

I wanted to know how the other repair companies in my home town were presenting themselves over the phone. Here are some of my competitors' opening lines:

Servicer Number One: "Hello, Friendly Service Company, please hold."

Servicer Number Two: "Thank you for calling TechnoFix. If you are dialing from a touch-tone phone, please press '1.' Please listen to the following options. If at any time, you wish this list to repeat, please press '6.'"

Servicer Number Three: "Hi, this is Sheri."

Servicer Number Four: "Blue Ridge Electronics. What do you want?"

I also went into these and other stores, sometimes as a consultant, other times as a make-believe customer with a pithy question. I listened closely to how customers were handled — particularly at the time of initial contact. Here are some typical clerk-versus-customer interactions:

Customer: "I'm having difficulty explaining what my VCR's doing wrong. Could I speak with a technician?"

Clerk: "No, customers aren't permitted to talk with technicians."

Customer: "I phoned you about ten days ago, and you said that the camera tech was on vacation, and not to bring it in until the 16th. Now, you tell me that the set is two days out of warranty, and you won't cover it."

Clerk: "I'm sorry. We don't make the rules."

Customer: "What do you charge for an estimate to repair this stereo?"

Clerk: "The estimate is $75 to $95."

Customer: "Wow! That much, just to look at it?"

Clerk: (Doesn't grasp the customer's incredulity. Doesn't realize that the customer was asking about the estimate charge, not the price-to-repair. And so, the clerk wonders why the customer is acting so weird.)

Some of you are going to get your hackles up, but the truth needs to have an outing. Many repair companies are woefully inadequate in how they present themselves to the consumer.

A great many of the people answering the phones or waiting on customers in electronics service companies are *un*helpful, *un*knowledgable and *un*smart. They are *un*marketing the businesses they work for. They should be counseled, documented, terminated, and replaced with people capable of bona fide customer service.

The typical service company owner, when faced with this observation, will usually come back with the following argument:

"I can't afford to pay my office people more than six or seven dollars an hour."

"But," I will counter, "these people are only partially performing an office function. For that, you can hire any drudge. The hard part of their job is customer service. And, for decent customer service, you have to pay more money."

Of course, by this time, the store owner is no longer listening. He's busy on the phone with an angry customer who was charged $39.95 to be told that his camcorder, which had fallen seventy feet

(continued on PR-2)

(The Right People, continued)

down a rocky cliff side and landed in saltwater, wasn't worth repairing.

A PROFILE OF COMPETENCE

Now that we've looked at a few varieties of ineptitude, lets take a look at competence. What makes a first-rate customer service representative for the electronics repair industry? Based on my own experience and the comments from successful servicers nationwide, here are the characteristics of a top-quality counter/phones person. He or she must be able to:

1. **Speak and write standard English.** In some communities, such as San Diego or Miami, it may also be helpful for the person to speak Spanish. The person should have legible handwriting. The person should not use a lot of slang.

2. **Soothe an angry customer.** The magic combination is firm, yet polite. Your counter/phones person must be willing to let customers have their say before chiming in. Also, this employee must be able to make concessions where necessary. (And you — as the owner or manager — must take pains to empower your counter/phones person with enough authority to toss a few bones to difficult customers.)

3. **Perform routine data entry and file retrieval on the store computer.** We have, in the year 2000, reached the point where ability to use a keyboard and computer are absolutely essential to good customer service. In our business, accuracy and attention to detail are more important than speed.

4. **Sell repairs and accessories.** A customer may be waffling between getting a set repaired and buying a new machine. An able counter/phones person should be able to tip the scales in favor of repair. He or she should be able to select and sell appropriate accessories.

5. **Render customer service courteously.** Let's admit it: The marketplace has become increasingly rude. A quality counter/phones person should engage in niceties such as calling customers by name, thanking customers for choosing their store, and prioritizing phone calls and in-person contacts so that people won't feel ignored or stuck on a back burner.

6. **Maintain a physical appearance that indicates personal pride and a sense of appropriateness.** Your customer should respect your counter/phones person, and he or she should dress so as to engender that respect. Clothing should be clean and pressed. Suggestive clothing should be avoided. (Those of you who require that your people "dress up," — please don't go overboard.)

7. **Politely turn away irreparable junk at the counter.** This requires some technical savvy — the ability to identify sets that have major physical damage, or that are irreparably old, or that have been invaded by Cousin Charlie on the kitchen table. If your counter/phones person is a techno-idiot or mechanical fumble-fingers, he or she is wrong for the job. Remember that nearly every time a customer has to pay a diagnostic fee to find out a set should be thrown away, the customer feels the money too was thrown away.

8. **Be able to explain basic operation of, and demo, common equipment.** Here also a little technical ability is a must. Some customers demand to see their units working correctly when they pick them up. Other customers are nearly helpless in a high-tech world. Your counter/phones person should be able to field common questions and demo basic operation of camcorders, DVD's, etc. In elaborate cases, you can charge customers for this "education."

9. **Ask probing questions when a customer can't clearly say what's wrong.** Many customers assume they know what their equipment needs, and skip right over a straightforward description of the symptoms. Your phones/counter person should know how to get the customer to come forth with a specific operational complaint.

10. **Tell the difference between an estimate charge and an estimated cost to repair.** Of all the misunderstandings that arise between consumers and dealers concerning repair charges, the number one snag is this ambiguity between the cost to render an estimate and the total repair charge that the estimate refers to. When a counter/phones person blows it, the customer will always say something like, "They wanted $95 just to look at it." Your employee must have a clear sense of the difference between an estimate charge and a total price to repair.

11. **Get along with co-workers.** The ability to work smoothly with others cannot be over-emphasized. Many employees achieve their productivity at the expense of other employees. You want someone with a positive, supportive attitude toward others.

A GOOD INVESTMENT

Inevitably, you cannot hire a person with the above skills for six or seven dollars an hour.

Remember what was said earlier: Only a fraction of the job is "office" work — a majority is customer service. Three common threads running through the profile of competence presented above are: communication skills, friendliness, and technical savvy. In our business, these define customer service.

The counter/phones person must get the customer to enjoy coming to your store, while at the same time painlessly squeezing out of the customer the information the technicians need to get the set fixed properly. This is why in so many successful small repair companies the owner runs the counter and phones.

You may have to pay $10-12 an hour to hire — and keep — a good quality counter/phones person. However, this "investment" will be outweighed several times over by the following profit-generating benefits:

- Lots more incoming calls will turn into customers walking through your door.
- Lots more customers walking through your door, who have viable repairs, will

(continued on PR-4)

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CURING OVERLOAD

(continued from page 80)

two sides, is not recommended. The overlapping flange type is superior to the butt-fit type. Even with the overlapping flange type, it's wise to use sheet-metal screws to help seal the enclosure to RF.

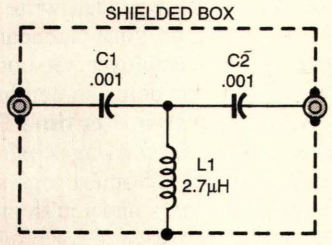

Fig. 6. A "universal" high-pass filter is shown here. It was designed to pass frequencies above 3000 kHz and attenuate those below that level.

When connecting the filters or attenuators to a receiver, it's all right to place the unit in series with the antenna line and couple its output to the receiver's antenna input through a short length of coaxial cable. It is better, provided that the receiver configuration allows it, to use a double male coaxial connector to connect the filter or attenuator directly to the antenna connector on the receiver.

Conclusion. Receiver overload problems are seemingly intractable and are always a bother. They can be defeated through some of the methods outlined in this article. P

SERVICE CLINIC

(continued from page 34)

sequences. We will discuss these topics in future VCR-focused installments of *Service Clinic*.

Wrapup

That's it for now. Next time we will talk about what could give your tired, misbehaving VCR like-new performance: namely, cleaning and rubber parts replacement. Until then, check out my Web site, *www.repairfaq.org*. I welcome comments (via e-mail only please) of all types and will reply promptly to requests for information.

See you next time! P

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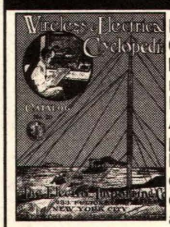

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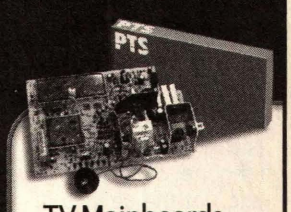

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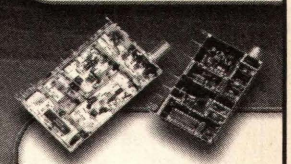

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(The Right People, continued)

leave them to get fixed.

- Fewer customers will get angry with you, and, of the few who do get angry, most of them will ultimately get satisfied without raising a major ruckus.
- The positive attitude on your phones and at the counter will rub off on your other employees and on you. This will increase productivity.
- Satisfied customers will create a great amount of word-of-mouth advertising.
- Because you will be perceived as a premium service, you will be able to raise your prices.

Fred Longworth MBA is the owner of StereoTech, and Longworth Consulting in San Diego, CA. §

Telephone Tips

"Hello, Honest Abe TV Repair. We are just too busy and we don't have any time to help you. You'll have to go somewhere else."

Businesses don't actually answer the telephone in this manner. If they did, they wouldn't be in business very long. But when a customer or prospect calls and no one answers, or the line is busy, or it rings fifteen times before someone picks up, you are, in effect, pushing away that person and more business along with them.

The telephone is one of the most important tools you have in your business. Customers form a mental picture of your company from the tone of your voice and the way the phone is answered. Your mood comes through whether you are the receptionist, salesperson or the president.

If you are taking messages, make sure you are accurate and complete. This goes for anyone who answers the phone, not just the receptionist. Be sure to get the caller's full name, company name and phone number. To make sure you have the right information and correct spelling, read it back.

Nothing irritates callers more than uninformed employees. If you are having a special sale this week, tell the receptionist so she'll know where to direct the call.

If you use electronic answering devices, be sure to check your outgoing message occasionally. The messages in some devices deteriorate in time. Re-record your message as needed.

And, never put a caller on hold without asking permission. Just asking the questions means nothing if you don't wait for an answer. Remember, your company image is literally *on the line.*

— Management —

Your Working Environment

There's an old saying, "You can catch more flies with honey than you can with vinegar." The same is true of the workplace.

by Nancy Buchanan

More than ever, employers are seeing the value of a motivated staff. Workers, such as receptionists, secretaries, and technicians bear much of the brunt of an economic climate that forces businesses to cut costs and improve efficiency — often with fewer people. These days, employers — or increasingly, their office managers — must act as coach and counselor if they don't want to be burdened by high turnover, absenteeism, and office malaise.

"It all comes down to keeping employees enthusiastic and energized," says management consultant Peter Economy, co-author of *Managing for Dummies.* "You have to do whatever you can to support them, so they are giving their all, all day long."

For you, the manager, that means developing a leadership style that will foster the ideal atmosphere in your office. It's up to you to create a place where staffers feel valued, where their opinions count and are respected, where there is open communication, and a spirit of teamwork.

All of your employees should feel they are a part of things. The atmosphere of the business should cause them to *want to* stay late rather than *have to* stay late. They should *want to* do something right rather than *have to* do something right. They must also realize that if they don't do the right thing, they are accountable.

How do you create an atmosphere like that? Here are some tips:

Thank them. Saying "thank you" to your staff when they do something right is the single most powerful motivator you have. Yet entrepreneurs, perhaps because they tend to be self-motivated, are notoriously stingy with praise.

High achievers often get their reward just from achieving something. They don't realize that the people who work for them need to be given verbal thanks to feel good about what they've done.

Be quick to pass on the compliments from customers. When a customer says, "I'm really glad your tech took the time to explain the situation to me," the employee should be thanked.

If you need a reminder, write the employee's name on your calendar. Every week, pick one employee. Go out of your way to catch him doing something well.

Adapt your style over time. Employees go through several stages before mastering their jobs. Some progress more quickly than others, and you should adapt your leadership style accordingly. New employees need clear instructions on what you want from them. Give them precise directions, or have another worker train them. But don't stop there.

Next comes coaching. Workers gradually grow disillusioned when they have trouble getting a handle on what they're supposed to do despite plenty of direction early on. Don' let them flounder. Check on them often, be encouraging, and direct them a bit more.

Later, when they've shown they can do the job but still aren't sure of themselves, ask them for suggestions on better ways to get the job done. Displaying an interest in them shows your support, and boosts their confidence. If their ideas fall short, tactfully tell them why, and they'll learn more about how you make decisions.

Encourage initiative. Give them the power to make changes when they see a way to run things more smoothly. Having the freedom to make changes not only makes their work more interesting, but knowing that the employer has confidence in their judgment helps keep morale high.

Involve them in decisions. The more you involve front-line workers in decisions, the more accurate information and insight you'll have about potential effects of any changes you want to make. Furthermore, studies show that when employees feel they've been consulted, they work harder to make a change work because they have an emotional stake in the outcome.

Hold them accountable. Some leaders do all the right things to make people feel good, to empower them and make them part of things. However, they fail to act when somebody steps out of line or simply isn't doing a good job. The result is a crumbling of the entire process.

(continued on PR-5)

(Working Environment, continued)

Don't wait for annual performance reviews to give feedback. Ask an employee to join you for a soda in the afternoon, and tell him how he's doing. If you're troubled by his performance, have your conversation in private. Be specific about your concerns. Buffer any criticism with a positive comment about something he's been doing well.

Consider giving them a financial stake. Bonuses don't always work well as incentives. If the dollar amount never varies much, employees tend to count on the extra money as salary. Yet, some employers report good luck with their policy of giving annual bonuses based on the company's overall productivity. Individual checks may not be tremendous, but some employees view their bonuses as strong motivation to keep costs down. That kind of teamwork is one of the strongest arguments for incentives tied to group performance.

Rewarding the entire group is a smart and powerful way to encourage everyone to find ways to improve coordination, cooperation, and sharing. It is also a good method to entice your most productive people to help your least productive employees improve.

(continued on PR-7)

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— Management —

Thoughts on Empowerment

The "knowledge worker" has begun to be synonymous with the success of organizations in the 1990s. Empowerment is key. The only way to ensure that organizations get the best thinking people have to offer, is to create an environment where people feel free to do their best work.

by Rick Maurer

People are empowered when they are given the authority and responsibility to make decisions affecting their work with a minimum of interference and second guessing by others. Empowerment is an overused and under-practiced term. When people are empowered they bring their minds to work. They are engaged in making decisions that affect their part of the business. They take responsibility for their actions. They work free from the petty bureaucratic hassles that diminish value and waste time. They add value to the organization by embracing the principles of quality and service. They search for ways to make a difference.

EMPOWERMENT IS CRITICAL

Most organizations need knowledge workers — men and women whose chief resource is their ability to think and act on what they know. Computer programmers, systems analysts, accountants, lawyers, managers, sales teams, and even factory workers must use their best judgment to solve problems and respond to opportunities.

Nordstrom is legendary in its customer service because it encourages and expects staff to make decisions that will make customers happy. A local Nordstrom store gives new staff a one-page employee handbook to illustrate this point. It reads, "Use your best judgment at all times."

WHY EMPOWERMENT WORKS

Most people want a few basic things from work:

- Meaning
- Results
- Challenge and an opportunity to learn
- Respect and recognition
- Control over their own part of the work
- Affiliation, or knowing they are part of a bigger team.

These six items form the foundation of all good empowerment efforts. When any of them are removed, you weaken the individual's commitment to his or her work. Fortunately, with regard to motivation, *what's good for the individual is also good for the company.*

MAKING EMPOWERMENT WORK

Build on the Six Motivators. Consider these items as a bedrock for all initiatives to increase empowerment. In addition, consider the following:

Clear Vision and Direction. Corporate leadership must know why it wants empowerment.

- What do you want to achieve from it?
- What would empowerment look like here?
- How committed are you to making empowerment a reality? (Is it essential or simply something that would be nice to have?)

Examine your corporate actions.

Policies. What gets rewarded gets done. What gets punished gets avoided. Corporate policies and procedures such as performance review and merit increases show people what is really important to senior management. For example, if people are told to work collaboratively but their performance reviews pit them against each other in forced appraisal ranking, people will protect their own self-interests. If you encourage cross-functional teamwork, but performance reviews only acknowledge work accomplished within a department, interdepartmental cooperation will suffer.

Unwritten Rules. These norms tell people how the game is played. People learn that these unwritten rules are as important as any written policy. For example, a manager may tell staff to always tell him or her the truth, but proceed to punish the messenger who brings the bad news.

Structure. To borrow a phrase from David Hanna's book, "Organizations are perfectly designed to get the results they get." NUMMI is a highly successful auto manufacturing plant that relies on high worker commitment and skill. It replaced a terrible GM plant in which absenteeism

was running at 25% the year it closed and where quality was a joke. Ironically, when NUMMI opened it hired back many of the same seemingly unmotivated workers from the old plant. The only major difference between NUMMI and its predecessor was how it was managed. People were free to stop the assembly line to solve quality problems. They were encouraged to learn many different tasks so they could add greater value to the assembly process. In short, they were empowered.

DIFFICULT TO ACHIEVE

Tom Peters once said, "we are only at the advanced lip service stage." I agree. We often are afraid to trust that others will actually do the work without close scrutiny. I never met anyone who said that a rigorous performance appraisal system helped him or her do better work. Yet most managers believe that it is an essential tool to use to motivate others. (If only those other people were as trustworthy as we.)

Watchful eyes breed dependency. When people try to please mom and dad they fail to take the risks and initiative needed to help a dynamic organization thrive. People wait to be told what to do. As the sign in a French civil servant's office read, "Never do anything for the first time."

If your work is going to be reviewed, folded, spindled, and mutilated by five others up the line before it is approved, why bother giving your best effort?

Our current view of organizations is based on hierarchy and chain of command. People above you make the decisions, people below carry them out. This model is firmly entrenched. Sometimes I think it is encoded in our DNA. It can only change when we see that it works against initiative and empowerment, and when we are willing to step back and take a cold sober look at they ways in which our own actions may be creating the dependency and lackluster performance we abhor.

THERE IS HOPE

There is a revolution going on in corporations. Since Peters and Waterman's watershed book, In Search of Excellence and our discovery of W. Edwards Deming in the early 1980's, organizations have been experimenting with ways to increase employee involvement. Even the federal government is trying to reinvent itself using principles of empowerment. Some organizations succeed, others fail — but we can learn from them all. These brave companies and agencies are providing the living textbooks that can point the way to new models of organization that treat people with dignity and respect — and serve the interests of the business.

Here are some examples of how others are using the principles of empowerment:

Large System Change. Organizations such as Corning get everyone (or at least a representative sample of all levels of the organization) in a room to reengineer their portion of company. Since this planning process involves those who must implement the changes, resistance decreases and commitment increases, planning and implementation time are compressed, and the quality of the plan often far exceeds what outside consultants or a small team could have created.

Cross-functional Teams. Companies such as Conrail pull together talented people from the middle of the organization and empower them to tackle pressing business challenges. These teams are more than task forces — they have the power to recommend and implement change.

Access to Information. Many organizations are examining how work is done in an effort to streamline service to customers. They develop new procedures that ensure the people closest to the work have immediate access to the tools and information they need. (In traditional organizations information is power and often kept away from those who need it most.)

Promote the Best. The best management book of 1991 was General Electric's 1991 Annual Report. In it, Jack Welch introduced his theory of leadership. GE needs people who keep commitments (meet deadlines and financial targets) as well as people who promote the values of the company (empowerment, etc.). In the past, they only gave lip service to the values goal. It was nice, but it didn't drive promotions. To get ahead you had to meet the numbers. Welch went on record as saying those days were over. He wanted men and women who could accomplish both goals. To prove his resolve, he timed the firing of some visible old-line managers with the publication of the report.

TO BEGIN THE CONVERSATION

Here are a few random questions to begin your company's conversation on empowerment.

- Do we agree that empowerment is a key ingredient in our continued success? If so, why? If not, why not?
- Does our performance review process support or hinder participation and commitment of all staff?
- Do we compensate and promote those who embody the values we espouse?
- Do our communication channels promote or inhibit free exchange of information and ideas between individuals and departments?
- What informal messages do people receive about our culture? What impact does this have on productivity and morale?
- What do we suppose employees say about our organization when we aren't in the room?
- Once people are trained and have proven their competency, do we have the courage to trust them?
- What happens when someone takes an educated risk and fails?

Of course the list could go on, but these should be sufficient to begin a provocative dialogue on the subject.

Rick Maurer is the author of "Caught in the Middle," and "Beyond the Wall of Resistance." He can be contacted at Maurer & Associates, 703-525-7074; e-mail: rick@beyondresistance.com; or visit his website for more information at www.beyondresistance.com. §

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by Mary Walton, forward by W. Edwards Deming

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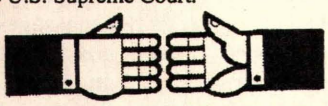

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— Professional Servicers —

Coping with Difficult Employees

When an employee begins staying late at the office — but falling as far behind in her duties as ever — you know you have a problem on your hands.

by Kenny Jenkins

Employee work-style problems, while a pain for workers and employers alike, become especially destructive when they affect customers. If the customer isn't greeted in a warm or courteous manner, they feel as though they're just a number. Customers who are treated brusquely may discontinue their relationship with that servicer. To prevent that unhappy situation, customer satisfaction forms can be used to monitor employee performance.

Some managers stress the concept that 'there's no "I" in Team,' feeling that the one-for-all approach promotes that team concept. They believe that troubled work environments have a way of working themselves out. Often, employees who really can't fit into the group will either leave because they're unhappy, or will find a place to fit in.

Others believe that office conflicts can best be healed by taking an aggressive approach with difficult employees. Rarely is it necessary that someone "has to go."

Employees represent a wide variety of work styles. Here are some of the most common types you might find in your

(continued on PR-8)

(Working Environment, continued)

Make them feel safe. Sit on any urge to punish mistakes. Encourage office staff to speak up if they see a problem. You want them to tell you when they make a mistake. Use encouraging lines like, "I know you'll get it right next time." Consider giving them extra training before resorting to reprimands or punishment. Not only does negative reinforcement fail to improve performance, but employees on the receiving end usually try to avoid the boss.

Likewise, make sure employees feel safe enough to point out problems. Otherwise, the company loses an opportunity to improve.

Be open. Employees want to know what's going on, good or bad. Be frank. Correct false rumors before they affect how people feel about their jobs. Call a meeting. People would prefer to hear even bad news from you personally, rather than read it on the bulletin board, or in an e-mail sent to their computer.

Be flexible. Bend when you can, rather than being rigid or bureaucratic. The business' needs should come first, but whatever you can do to be flexible and understanding is really going to pay off for you.

Treat employees as people, not underlings. Taking an employee to lunch is a real morale booster. Some other suggestions are: give birthday cards signed by everyone in the office, or inexpensive gifts such as a coffee mug or a plant to recognized special efforts. Have "pizza days" in the staff room.

Pay enough. If you aren't paying the going rate — with benefits — no motivational strategy is going to work. To stretch your office budget, consider using incentives that cost less than a raise, but make workers feel valued. These might include an extra vacation day, an afternoon off for holiday shopping, or a better parking space. Send employees to classes, seminars, or conferences. Pay for their prpofessional certification, or the annual dues for a professional association.

Back off, if you delegate. Most employers don't want the day-in, day-out responsibility of managing staffers, and they delegate much of the job to an office manager or administrator. That's fine, experts say, but be sure you really put the manager in charge. Otherwise employees will constantly dismiss what the manager says, while trying to figure out what you want.

When the office manager can say to the employer, "Don't countermand directions I just gave," then you have a good relationship and a good setup.

And finally, one more piece of advice to employers: keep in mind that no matter how much you may try to distance yourself from anything managerial, you have a tremendous effect on office morale simply because of your position. Wear it responsibly. §

business, and some expert advice to help you handle them.

THE CONTROL FREAK

This employee — often a competent worker — seems convinced that he or she is the only person who can do any given task correctly. You may find yourself praying a control freak never falls ill or takes a vacation, because she's the only one who knows how the office runs. In the meantime, the control freak, unable to delegate, becomes overburdened, and may create a bottleneck that slows down the rest of your staff.

If you've got a control freak — or any other problem employee in your midst — first try to diagnose what rewards the employee gets out of his or her behavior. In the case of an employee who "does it all," maybe they like getting the credit. Or, maybe they're a closet perfectionist.

Put your expectations for all your employees in writing. Formulating a job description for each position, which employees would approve and sign. This policy might help cut down on 'job creep,' — doing things that are under someone else's job description.

It is a good idea to observe any problem employee over a period of time to detect behavior patterns. Does this behavior happen when she's under stress, or does it happen all the time? Since everyone has their bad days, you might choose not to make a big deal out of it.

If the problem behavior does prove to be recurring, sit down with the employee and give concrete examples of the difficulties. Avoid sweeping statements that begin with "you never" or "you always." Specific criticism, using the employee's own job description, can bolster your argument.

But what about problem behavior that arises only in a crisis? Take charge if the situation. Be specific and direct. When they're under stress, they're not making good decisions.

And, you might want to consider that your employee is overloaded because the job requires more work than one person can perform. In general, employers fail to hire enough help when it has to come out of their own pockets. It may be in the company's best interest to either hire more help, or provide training in human relations or time management to existing staff.

THE CLOCK PUNCHER

A clock puncher may do a good job — but only for exactly eight hours a day, and not a minute longer. When the end of the shift comes, the clock's minute hand has barely clicked into place before he or she is heading out the door. That means that a lot of work time is spent monitoring the clock rather than work. Your requests that the clock puncher take on an extra duty or two are met with immediate resistance. This problem employee isn't going to give you anything but the bare minimum — and they don't seem happy about giving even that much.

In a small office, this kind of less-than-dedicated employee can cause big problems. There will be occasions when they will not be able to leave as scheduled.

Clock punching could be a problem with employee morale. The problem might also be due to an expectation gap. Perhaps you assume that an employee knows how to do a task that he is unfamiliar with, and so he avoids doing it. It's unfair to ask someone to do something they're not trained to do, and could in some circumstances be dangerous.

The employee's lack of enthusiasm may stem from a problem with another coworker, or even personal troubles. Don't be afraid to approach the employee and ask what's bothering him. One approach is to say, "I sense that you're a little down about work. Is there something I need to know?" Sometimes there's resentment toward the manager for not picking up on a problem, for not 'mind-reading.'

Sometimes the message the employee is trying to telegraph by using withdrawn behavior is job, or at least financial, dissatisfaction. Be aware of the economic gap between employees and employers. Your employees might not be receiving the same intangible rewards from their jobs as you are from yours, such as praise and respect from customers.

Point out examples of more dedicated employee behavior to motivate clock-punching employees to pay more attention to their work and less to their wristwatch. For example, at a meeting one might say, "I want to thank Tom, who put in an extra hour when we were in a crunch last week."

THE BROWN-NOSER

It's called 'high career visibility.' An employee forces a manager into acknowledging the employee's work by pointing out just how much he or she has really accomplished. A good way to counteract this behavior is to spread the praise around to other employees, to even things out. Make sure that the brown-noser doesn't become the shining star because of neediness. It's important for all of your employees to feel like they're treated even-handedly.

THE BACK-STABBER

Beware the brown-noser's evil twin — the employee to whom it doesn't matter so much that you think well of them, but that you think badly of their coworkers. The back-stabber loves to enumerate his or her peers' mistakes, never failing to mention how far behind everyone else is. "Thank heaven," the back-stabber seems to imply, "somebody here is a dedicated professional."

Cut this behavior off at the pass. When the finger-pointing starts, tell the back-stabber you're not comfortable talking about someone without them being there. Such a strategy sends two messages: that you're not interested in gossip, and that you are interested in solving problems.

However, if an employee has a legitimate concern, he or she should make it in writing. You don't want to close someone out who has a legitimate gripe.

If gossip and back-stabbing seem rampant in your office, look into bringing in a management consultant or springing for a management retreat for your staff that focuses on teamwork training. Left unchecked, backstabbing or other problem work styles can be destructive to your business. People can't work together when they have unresolved issues.

One solution to getting to the bottom of workplace disharmony is to administer a standardized personality test to all of the employees. Called the Myers-Briggs Indicator, it gives directions on how to help your employee.

While a standardized personality test might not be the solution for handling all employees with problem work styles — especially for smaller businesses — you should search for ways to get the most out of your personnel. There is a closeness and intimacy to small workplaces that many other businesses don't have. Often, issues don't get dealt with because they're low on the list of priorities. Employers sometimes feel either unequipped for or uninterested in solving employee work-style dilemmas. As a result, dysfunctional work relationships may go on for years.

As long as your office is staffed with human beings, you will have many personalities and work styles to manage. The key is not to eliminate differences or to try to make everyone the same, but to identify and correct potentially troublesome habits before they become destructive for your entire staff. §

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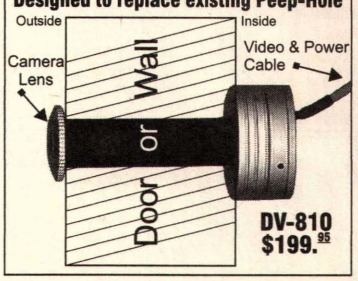

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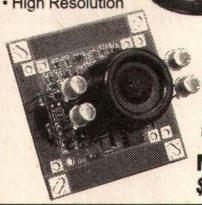

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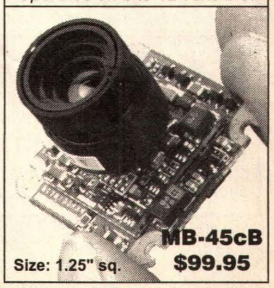

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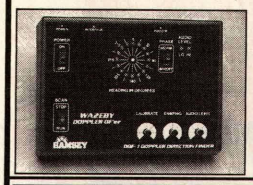

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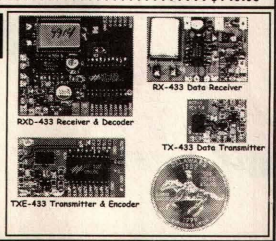

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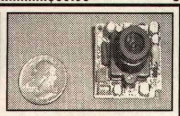

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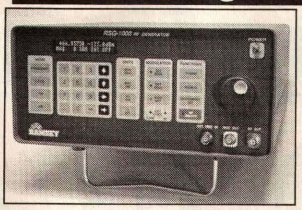
Matching Case Set (specify for which kit) $14.95

PIC-Pro Pic Chip Programmer

Easy to use programmer for the PIC16C84, 16F84, 16F83 microcontrollers by Microchip. All software - editor, assembler, run and program - as well as free updates available on Ramsey download site! This is the popular unit designed by Michael Covington and featured in Electronics Now, September 1998. Connects to your parallel port and includes the great looking matching case, knob set and AC power supply. Start programming those really neat microcontrollers now...order your PICPRO today!

PIC-1, PICPRO PIC Chip Programmer Kit $59.95

1 GHz RF Signal Generator



A super price on a full featured RF signal generator! Covers 100 KHz to 999.99999 MHz in 10 Hz steps. Tons of features; calibrated AM and FM modulation, 90 front panel memories, built-in RS-232 interface, +10 to -130 dBm output and more! Fast and easy to use, its big bright vacuum florescent display can be read from anywhere on the bench and the handy 'smart-knob' has great analog feel and is intelligently enabled when entering or changing parameters in any field – a real time saver! All functions can be continuously varied without the need for a shift or second function key. In short, this is the generator you'll want on your bench, you won't find a harder working RF signal generator - and you'll save almost $3,000 over competitive units!

RSG-1000B RF Signal Generator $1995.00

Super Pro FM Stereo Transmitter

Professional synthesized FM Stereo station in easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set freq with Up/Down buttons, big LED display. Input low pass filter gives great sound (no more squeals or swishing from cheap CD inputs!) Limiters for max 'punch' in audio - without over mod, LED meters to easily set audio levels, built-in mixer with mike, line level inputs. Churches, drive-ins, schools, colleges find the FM-100 the answer to their transmitting needs, you will too. Great features, great price! Kit includes cabinet, whip antenna, 120 VAC supply. *We also offer a high power export version of the FM-100 fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped if accompanied by a signed statement that the unit will be exported.*

FM-100, Pro FM Stereo Transmitter Kit $249.95
FM-100WT, Fully Wired High Power FM-100..... $399.95

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No drift, microprocessor synthesized! Great audio quality, connect to CD player, tape deck or mike mixer and you're on-the-air. Strapable for high or low power! Runs on 12 VDC or 120 VAC. Kit includes snazzy case, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized Stereo Transmitter Kit $129.95

Lower cost alternative to our high performance transmitters. Great value, easily tunable, fun to build. Manual goes into great detail about antennas, range and FCC rules. Handy for sending music thru house and yard, ideal for school projects too - you'll be amazed at the exceptional audio quality! Runs on 9V battery or 5 to 15 VDC. Add matching case and whip antenna set for nice 'pro' look.

FM-10A, Tunable FM Stereo Transmitter Kit..... $34.95
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CLPA, Matching Case Set for LPA-1 Kit $14.95
LPA-1WT, Fully Wired LPA-1 with Case $99.95
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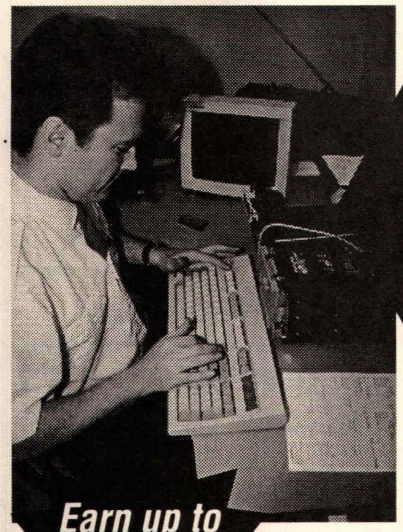

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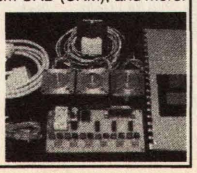

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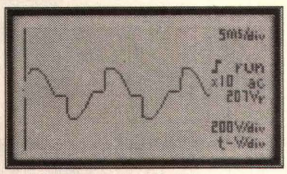
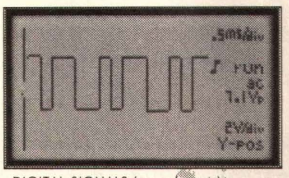
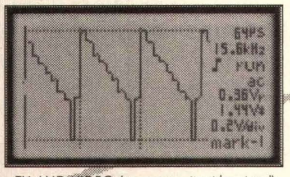


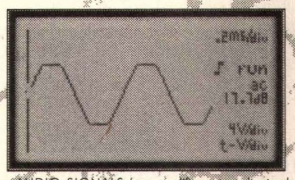
AC MAINS (e.g. phase control)



DIGITAL SIGNALS (e.g. pulse train)



TV AND VIDEO (e.g. composite video signal)



AUDIO SIGNALS (e.g. amplifier output clipping level)

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- Input sensitivity range: 5mV to 20V/div in 12 steps (up to 200V/div with X10 probe)
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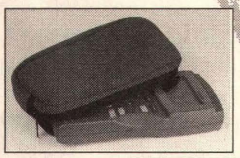

OPTIONS:
- Insulated measurement probe x1 / x10: PROBE60S
- Adaptor for 110VAC: PS905USA

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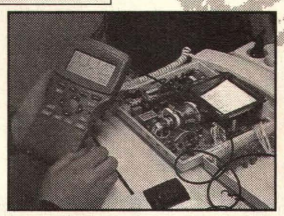

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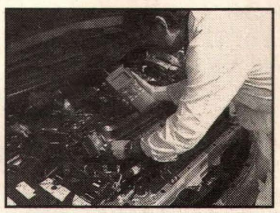

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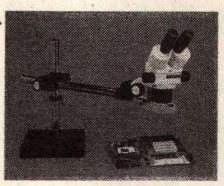

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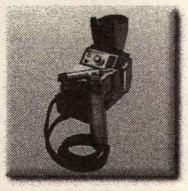

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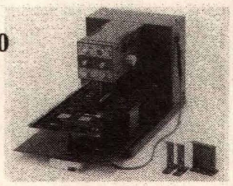

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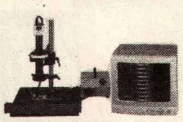

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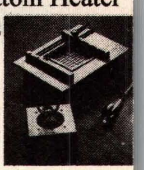

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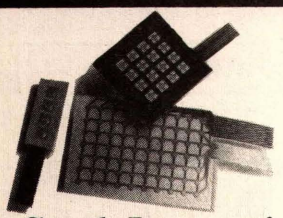

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1 Variable - 2.5 - 20V @ 2A

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- 5VDC @ 3A
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XP-720 Fully Assembled $85

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- Thermal Function
- Current Limiting

Model 1686 12A $169
Model 1688 28A $249

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Model 1680 6A $42
Model 1682 15A $75

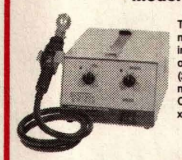
Elenco DC Power Supply Model SPL-603 3A 0-30VDC

The SPL-603 is a solid-state DC power supply providing the exact output voltage no matter what current you use. Output fully protected from overload.

$79.95

Soldering Equipment

Elenco Hot Air SMD Rework Station Model SR-979



The workstation is engineered to meet the needs of today's electronic industry. Wide range of adjustments of air volume and temperature (212°F to 754°F) permits soldering of most surface mount devices. Comes with an A1138 nozzle QFP 28 x 28mm (1.1 x 1.1").

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Weller Soldering Station Model WES50

50 watts of controlled power - designed for continuous production soldering.

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Weller Low Cost Soldering Iron Model WLC-100

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- Ideal for hobbyists, DIYers and students.
- Complete with 40W iron.

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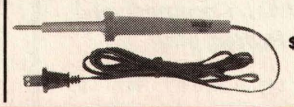
Weller Marksman® 23W Soldering Iron Model SP23



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Generators & Counters

Elenco Sweep Function Generator w/ built-in frequency counter Model GF-8036

$225

This sweep function generator with counter is an instrument capable of generating square, triangle, and sine waveforms, and TTL, CMOS pulse over a frequency range from 0.2Hz to 2MHz.

10 Function 1.3GHz Universal Counter Elenco Model F-1300

- Frequency .05Hz - 1.3GHz 3 Ranges
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- Stop-watch set .2 sec. to 100 hrs.
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- Pulse Width - 0.1ms to 66666.6ms

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Multifunction Counter B&K Model 1875

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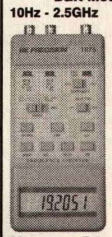

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Includes antenna, NiCad battery, and AC adapter.

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Features internal AM mod. of 1kHz, RF output 100MV - 35MHz. Audio output 1kHz @ 1V RMS.

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SG-9000 ..... $119.95 (analog, w/o counter)

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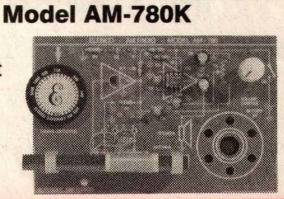

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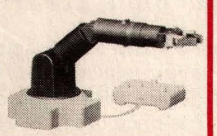

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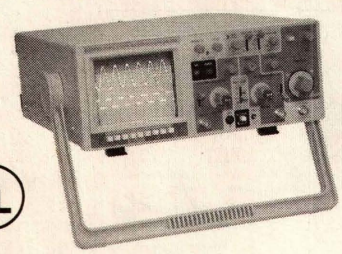

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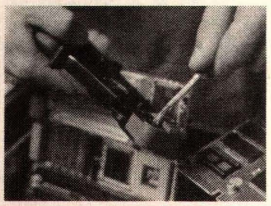

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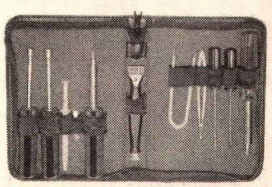

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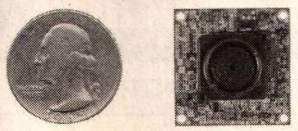

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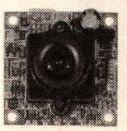

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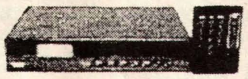

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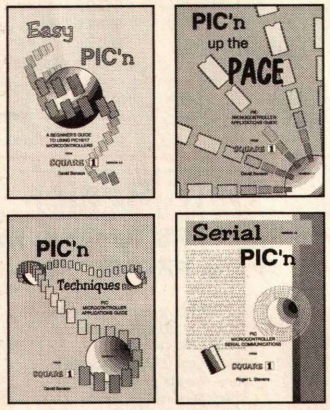

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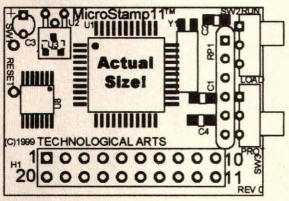

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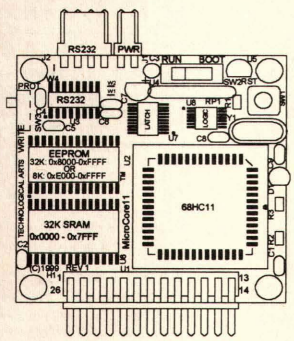

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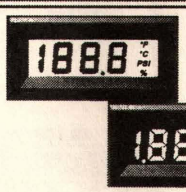

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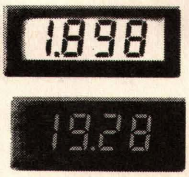

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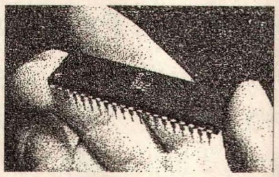

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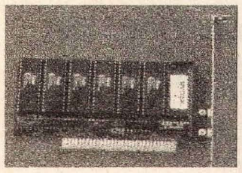

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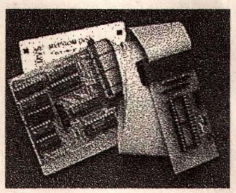

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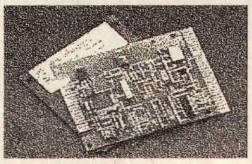
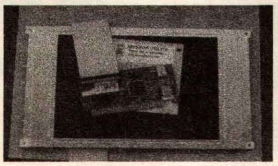


VGA LCD

640x480 controller for PC or SBC
$27 oem $75 eval



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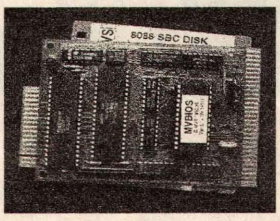
$27 OEM, Eval $95, includes: DOS, 3 ser, 2 par, rtc, NVmem, Built-in LED display, ISA bus, Keyboard and LCD interfaces.
COMPLETE !!!
Not a "core" or "engine". All utilities and tutorial included. Use Turbo C, BASIC, MASM. 386 version: $42 oem, $195 eval



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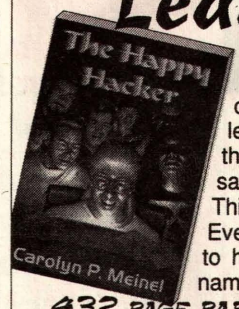

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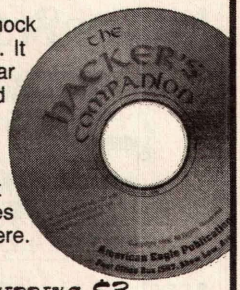

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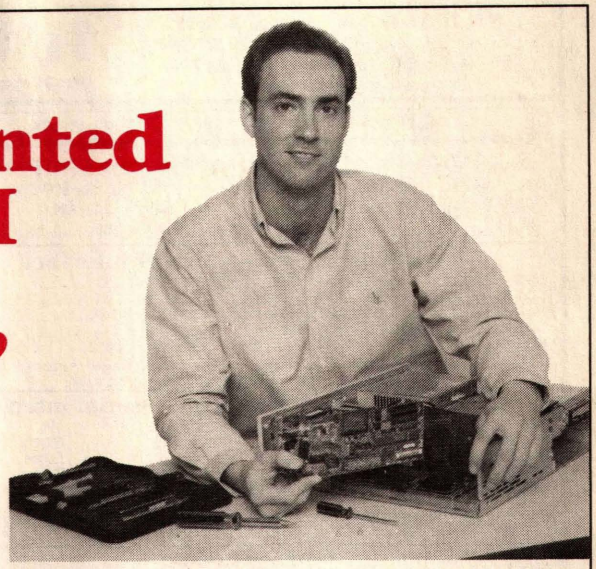

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5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • *Certain models are backlit, call for more info.*

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size	Mfr.	price	size	Mfr.	price
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Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

SONY Miniature Color LCD Display (LCX005BKB) $29.00

• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

1.8cm (0.7 inch) unit LCX009AKB 827H x 228V **$29.00**

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These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

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NTSC COMPOSITE 4" LCD MONITOR $69.00

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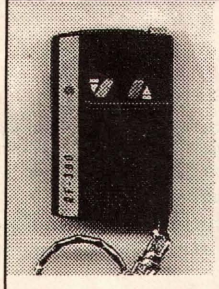
Miniature Transmitters and Receivers

2 Button / 3 Channel Transmitter



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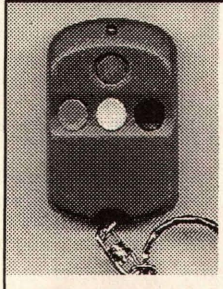
4 Button / 15 Channel Transmitter



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- 6,561 Settable Security Codes
- 12 Volt Battery and Keychain Included
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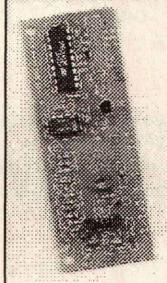
- Fully Assembled in Case
- Dimensions: 1.35" x 2.25" x .5"
- Push combination of buttons to achieve up to 15 channels

2-4 Data / 3-15 Channel Receivers



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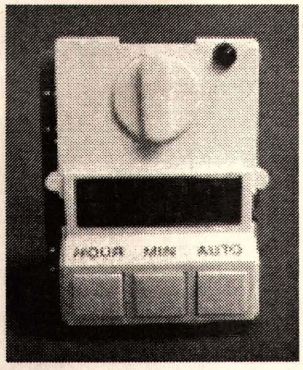

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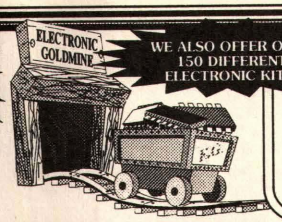
G1299 White SPT-2 Line Cord (for above) 49¢ ea.



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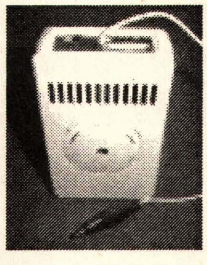
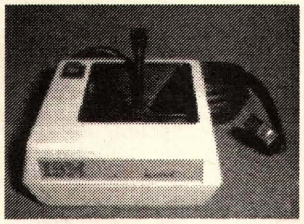


This is the best proximity alarm we have ever evaluated. It can detect your hand at one foot away. The alarm consist of an attractive compact 3 3/4" x 2 1/4" x 1" off white case with built in electronic alarm and antenna clip. The sophisticated highly sensitive circuit is activated when your hand or body comes near any ungrounded metal object which you have clipped the antenna lead to. Complete with silencer switch so that you can adjust the sensitivity of detection by a flashing LED without the alarm sounding. When you have adjusted the sensitivity control properly using the built in flashing LED simply turn on the alarm switch to provide alarm sounding. Brand new very nice!

G1757 $12.95

HIGH QUALITY IBM JOYSTICK



Very nicely made joystick made for IBM PC Jr. Can be used for hundreds of custom applications. Smooth action type with black lever flexible cable, red and black "fire" buttons. Also has "mode" change for X and Y on bottom. Size about 4" sq. Brand new in box.

G1774 $3.49

BAR CODE LASER SCANNER UNIT

Made by Spectra Physics, these are the model Freedom or Freedom Plus. They are about 11 3/4" x 9" x 3" and are loaded with laser goodies. There is a spinning 4 sided front surface mirror, a bunch of various size stationary front surface mirrors, a red laser (we assume diode), several circuit boards–one which is loaded with various ICs and electronic parts. We have absolutely no information on the hookup of these or whether they work. We were told that they are worth about $1,000 each, but we don't know for sure. These units were removed from stores so they are used and may have scratches or smudges on the outside of their cases. The label on the back of the unit states that it is a Bar Code Scanner and it requires 26V@600ma. Sold "as is" only–no returns. Hurry before we run out!

G1562EN ~~$24.95~~ EA. SALE! $19.95 EA.

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G1760 $1.29 •10 for $12.00
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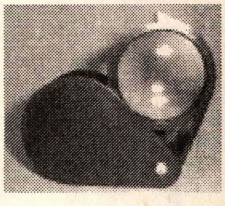

This is probably the largest magnifier loupe we have ever seen. Makes SMD components look huge! Great for all types of hobby or jewelry use. Magnifying lens folds out from black plastic protection casing. Powerful precision made magnifier is 6X power. Overall case size about 2 1/4" dia x 3 1/2". Brand new in box.

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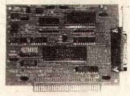

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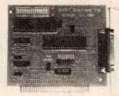

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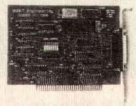

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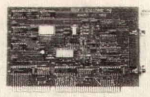

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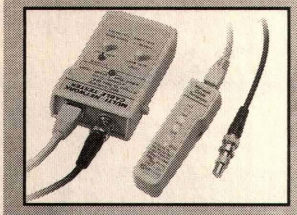

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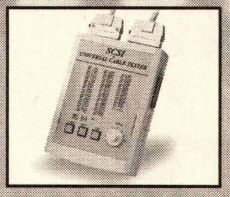

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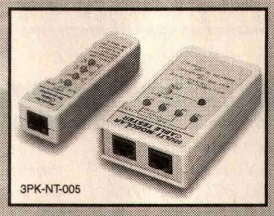

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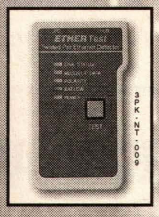

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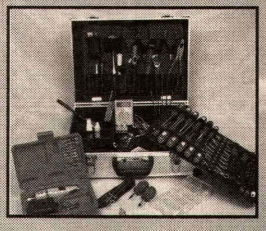

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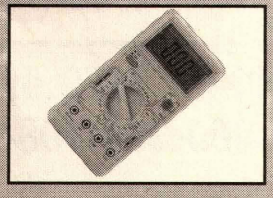

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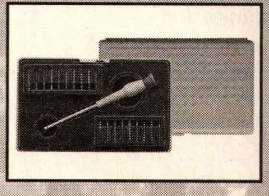

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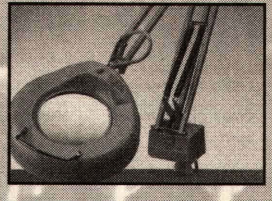

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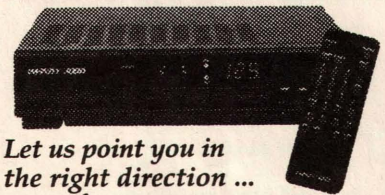

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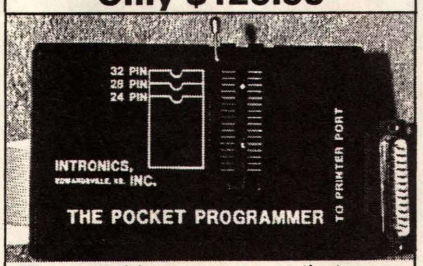

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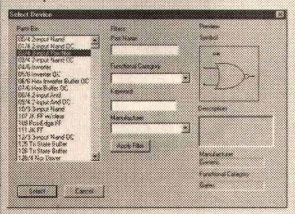

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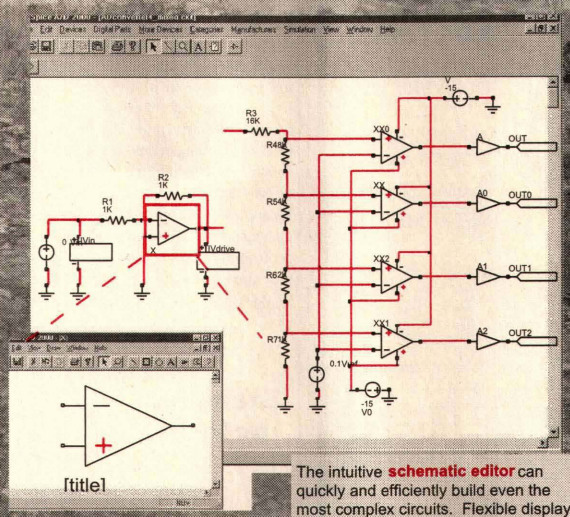

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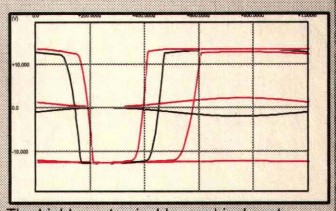

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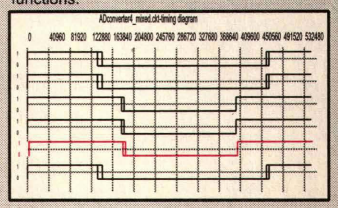

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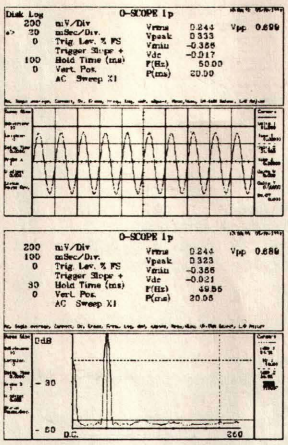

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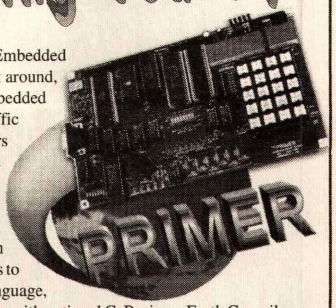

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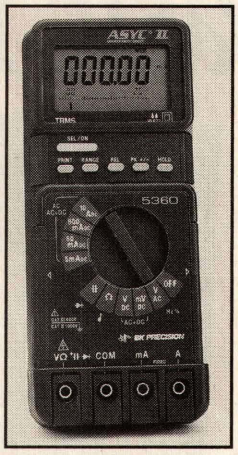

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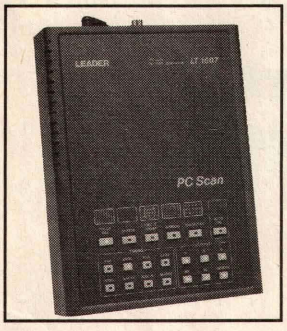

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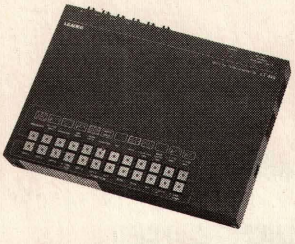

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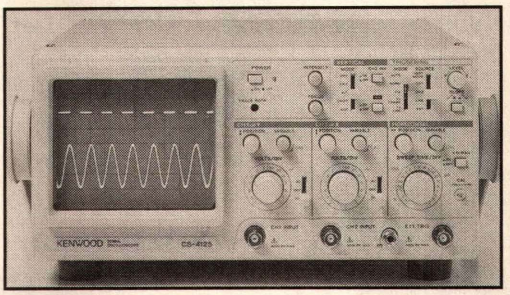

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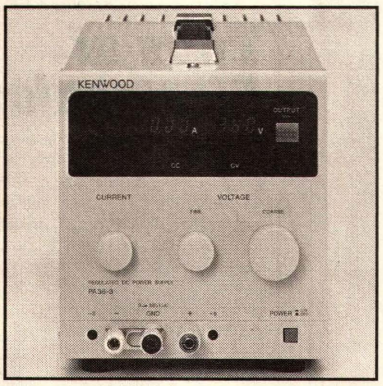

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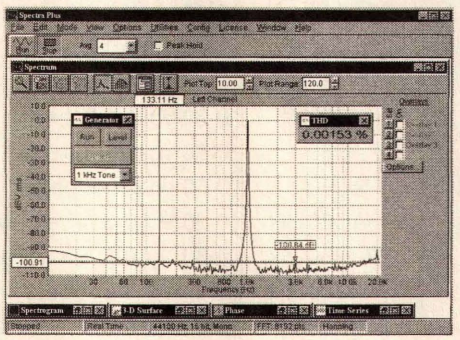

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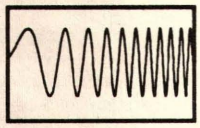
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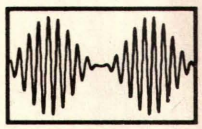
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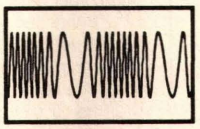
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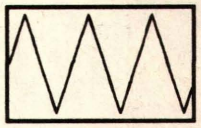
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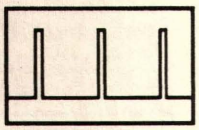
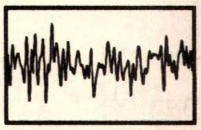
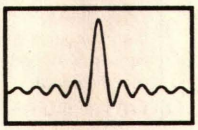

Pulse Generator


Noise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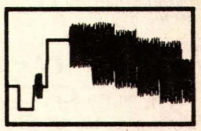
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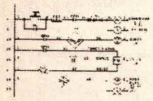
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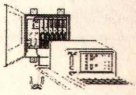

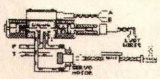
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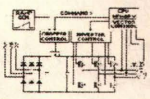

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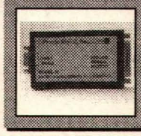
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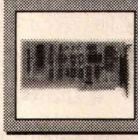
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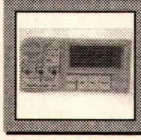
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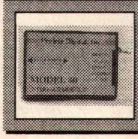
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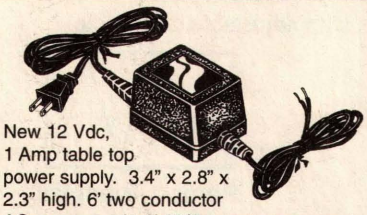

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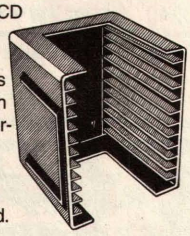

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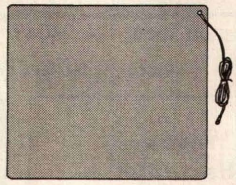

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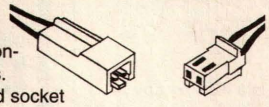

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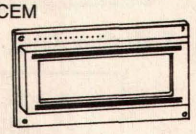

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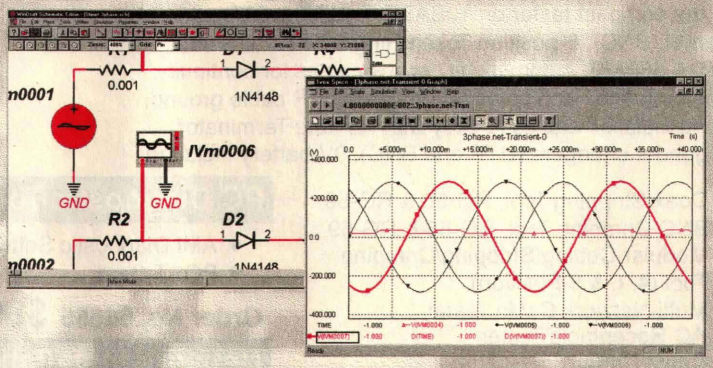

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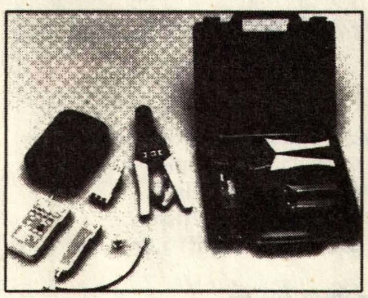

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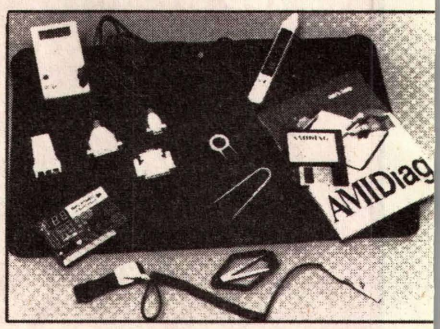

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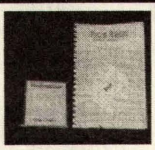

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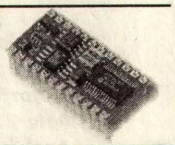

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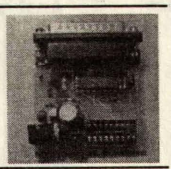

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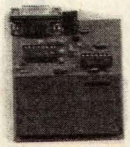

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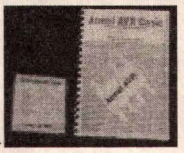

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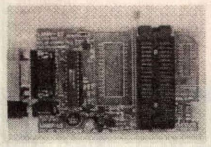

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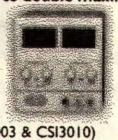

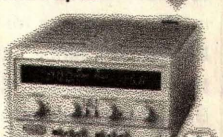

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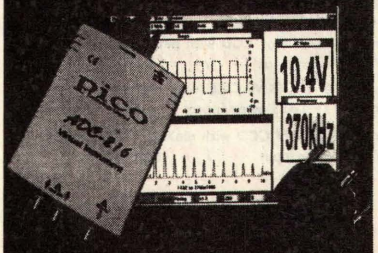

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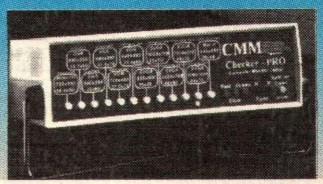

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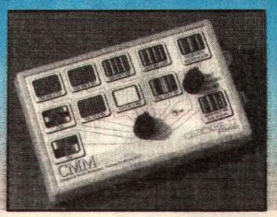

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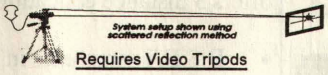

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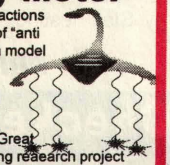

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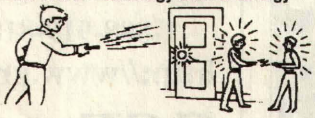

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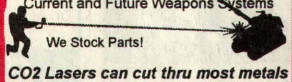

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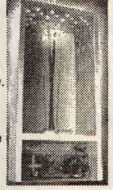

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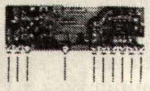

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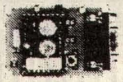

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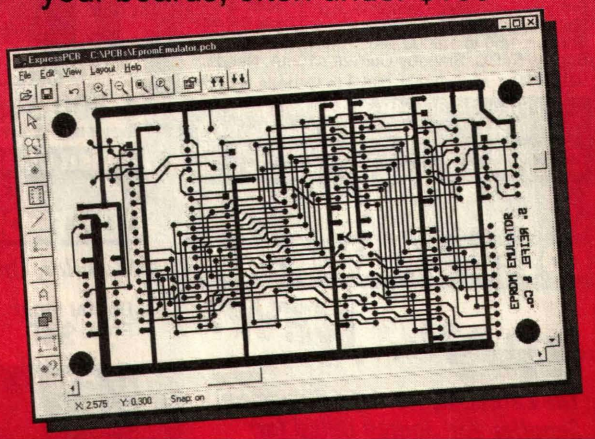

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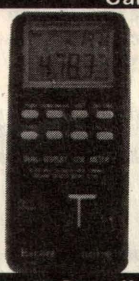

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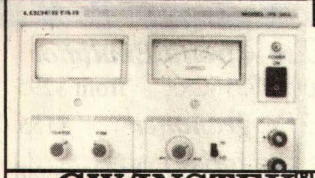

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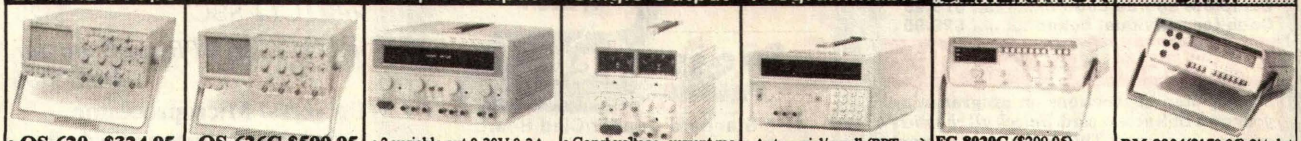

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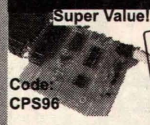

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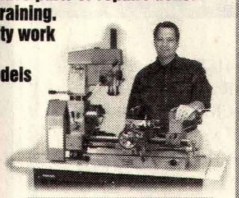

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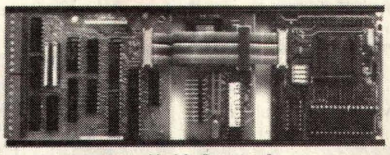

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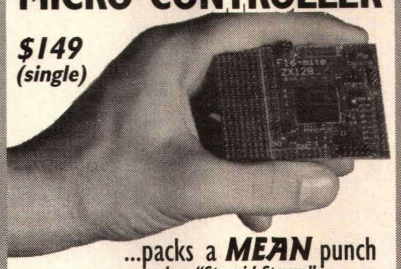

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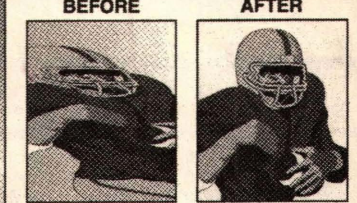

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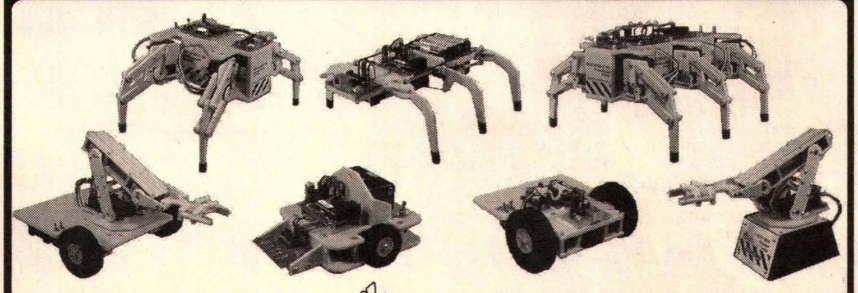

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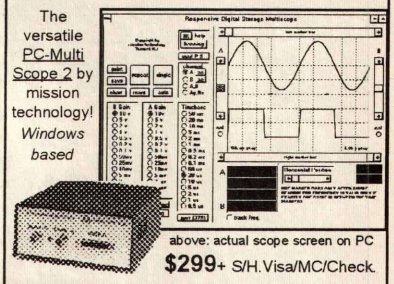

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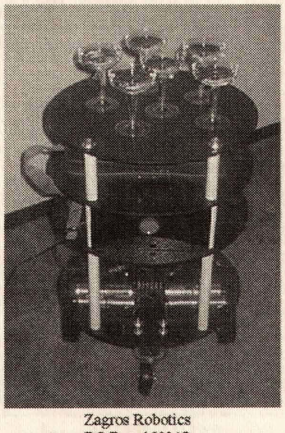

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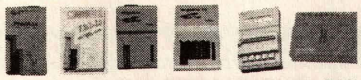

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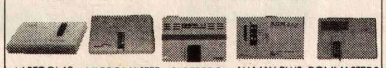

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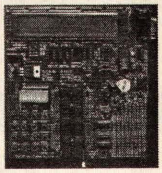

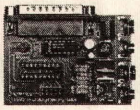

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Free Information Number		Page
—	Abacom Technology	115
—	ABC Electronics	100
255	Alfa Electronics	115
215	All Electronics	108
—	Allison Technology	102
—	Amazon Electronics	116
—	Amaze Electronics	118
315	American Eagle Publications	94
—	Andromeda Research	102
—	Arrow Technologies	100
295	AVEN Tools	99
—	Brand Electronics	89
—	Bsoft Software, Inc.	98
—	Capital Electronics	86
290	C&S Sales, Inc.	90
283	Cadsoft, Inc.	15
130	CircuitMaker	CV2
233	Circuit Specialists	111
—	CLAGGK, Inc.	46, 79
—	Cleveland Inst. of Electronics	51
230	Command Productions	85
—	Computer Monitor Maintenance	113
—	Conitec Data Systems	118
316	Dalbani	CV3
—	EDE Spy Outlet	93
312	Electronic Goldmine	97
133	Electronic Workbench	CV4
—	Electronic Tech. Today	56
—	Emac Inc.	102
—	Engineering Express	115
—	Fair Radio Sales	112
335	Foley-Belsaw	95
—	General Device Instruments	118
157	Global Specialties	61
—	Globaltech Distributors	117
—	Grantham College of Eng.	113
329	Graymark	110
237	Howard Electronics	88
—	Howard Electronics	100
—	I.E.C.	92
220	Information Unlimited	114
—	Intec Automation	117
—	Intelligence I^2 Inc.	116
—	International Hanbai, Co., Ltd.	7
—	Intronics	100
309	IVEX Design	109
—	J&M Microtek, Inc.	116
205	Jensen Tools	112

Free Information Number		Page
—	KNS Instruments	93
—	Lindsay Publications	118
—	Lynxmotion	117
—	M^2L Electronics	118
250	Mendelsons	106
296	Merrimack Valley Systems	94
310	Micro 2000	103
—	microEngineering Labs	118
—	Modern Electronics	106
—	Mondo-tronics	113
218	Mouser Electronics	92
—	MSC Electronics	117
—	NESDA	PR-9
—	PC Boards	112
—	Pioneer Hill Software	106
300	Polaris Industries	83
219	Prairie Digital	107
256	Print Products Int.	104
284	Prompt Publications	17
—	Pro Planet	117
150	PTS Electronics Corp.	PR-3
—	Pulsar	89
263	Ramsey Electronics	84
308	Rogers Systems Specialist	101
—	Saelig Co. LLC	112
—	Securetek	98
138	Sencore, Inc.	55
—	Sil Walker	89
—	Smithy Company	116
—	Super Circuits	106
—	Square 1 Electronics	92
—	Techniks	116
—	Technological Arts	93
311	Telulex	107
313	Test Equipment Depot	98
217	Tie Pie Engineering	89
242	Timeline	96
—	UCANDO Videos	107
—	Ultima Associates	113
—	Unbound Technologies	94
275	Velleman	87
—	Vision Electronics	117
314	Visitect Inc.	96
170	Wavetek Corp.	13
—	World Star Technologies	116
—	World Wyde	110, 116, 117
—	XX Box	92
—	Zagros Robotics	118
—	Zorin	116

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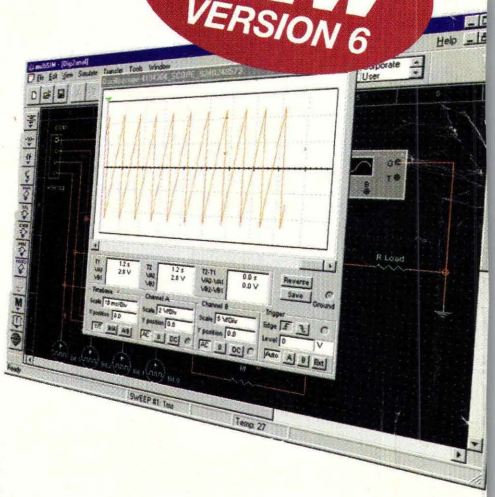

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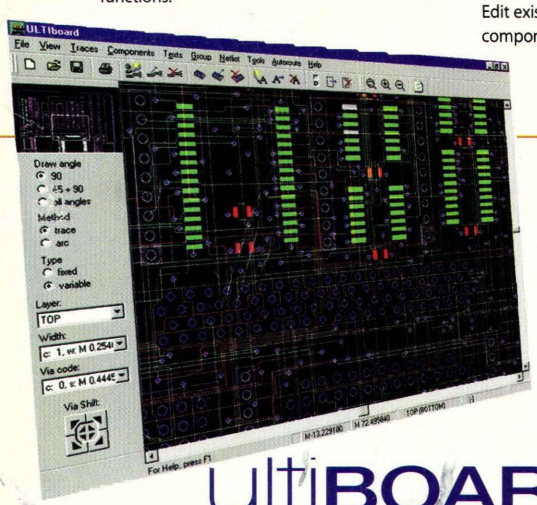

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